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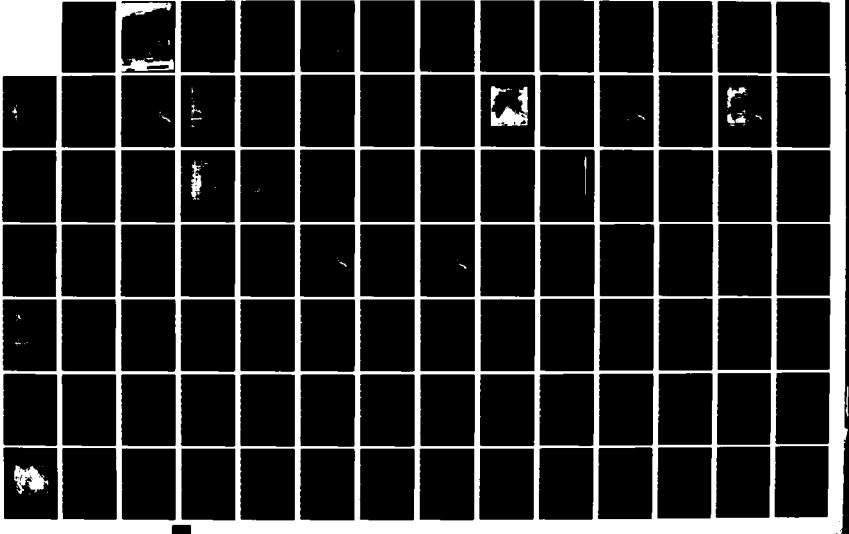

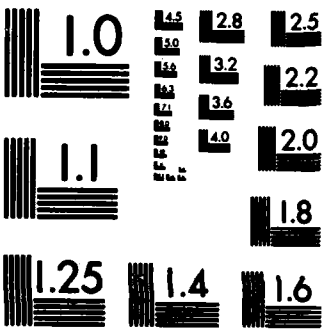

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water resources planning; water demand; water supply; Potomac River; groundwater; reservoir; raw water interconnection; Low Flow Allocation Agreement; Bloomington Lake; Little Seneca Lake; wastewater reuse; Potomac Estuary Experimental Water Treatment Plant; PRISM/COE; water pricing; water conservation; demand reduction; Cooperative Operations on the Potomac; flowby;

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In response to the Water Resources Development Act of 1974, the Baltimore District of the U.S. Army Corps of Engineers conducted a comprehensive water supply analysis of the Metropolitan Washington Area (MWA). Severe water supply shortages had been forecast for the MWA and the study was undertaken to identify and evaluate alternative methods of alleviating future deficits. Initiated in 1976, the study was conducted in two phases over a 7-year period. The first, or early action phase, examined the most immediate water supply problems and proposed solutions that could be implemented locally. The second or long

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19. KEY WORDS (continued)

water shortage; reregulation; finished water interconnection; Occoquan Reservoir; Patuxent Reservoir; Potomac Estuary; Water Supply Coordination Agreement; Verona Lake

20. ABSTRACT (continued)

range phase included an analysis of the full spectrum of structural and nonstructural water supply alternatives. In addition to such traditional water supply alternatives as upstream reservoir storage, groundwater and conservation, the study also considered such innovative measures as wastewater reuse, raw and finished water interconnections between the major suppliers, the use of the upper Potomac Estuary, reregulation and water pricing. A key tool in the study was the development and use of a basin-specific model that was used to simulate the operation of all the MWA water supply systems and sources under various drought scenarios. As the study progressed, local interests used the technical findings of the Corps' study to make great strides toward a regional solution to their water supply problems. The Corps' study concluded that with the implementation of a series of regional cooperative management agreements, contracts, selected conservation measures, and the construction of one local storage project to be shared by all, severe water supply shortages could effectively be eliminated for the next 50 years. The Final Report of the study is comprised of eleven volumes which provide documentation of both the study process and the results of all the technical analyses conducted as part of the study.

METROPOLITAN WASHINGTON AREA
WATER SUPPLY STUDY

APPENDIX A
BACKGROUND INFORMATION AND PROBLEM IDENTIFICATION

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland

September 1983

REPORT ORGANIZATION*

METROPOLITAN WASHINGTON AREA WATER SUPPLY STUDY

Appendix Letter	Appendix Title	Annex Number	Annex Title
	Main Report		
A	Background Information & Problem Identification		
B	Plan Formulation, Assessment, and Evaluation	B-I	Water Supply Coordination Agreement
		B-II	Little Seneca Lake Cost Sharing Agreement
		B-III	Savage Reservoir Operation and Maintenance Cost Sharing Agreement
C	Public Involvement	C-I	Metropolitan Washington Regional Water Supply Task Force
		C-II	Public Involvement Activities - Initial Study Phase
		C-III	Public Opinion Survey
		C-IV	Public Involvement Activities - Early Action Planning Phase
		C-V	Sample Water Forum Note
		C-VI	Public Involvement Activities - Long-Range Planning Phase
		C-VII	Citizens Task Force Resolutions
		C-VIII	Background Correspondence
		C-IX	Coordination with National Academy of Sciences - National Academy of Engineering
		C-X	Comments and Responses Concerning Draft Report
D	Supplies, Demands, and Deficits	D-I	Water Demand Growth Indicators by Service Areas
		D-II	Service Area Water Demand & Unit Use by Category (1976)
		D-III	Projected Baseline Water Demands (1980-2030)
		D-IV	Potomac River Low Flow Allocation Agreement
		D-V	Potomac River Environmental Flowby, Executive Summary
		D-VI	PRISM/COE Output, Long-Range Phase
E	Raw and Finished Water Interconnections and Reregulation	E-I	Special Investigation, Occoquan Interconnection Comparison
F	Structural Alternatives	F-I	Digital Simulation of Groundwater Flow in Part of Southern Maryland
G	Non-Structural Studies	G-I	Metropolitan Washington Water Supply Emergency Agreement
		G-II	The Role of Pricing in Water Supply Planning for the Metropolitan Washington Area
		G-III	Examination of Water Quality and Potability
H	Bloomington Lake Reformulation Study	H-I	Background Information
		H-II	Water Quality Investigations
		H-III	PRISM Development and Application
		H-IV	Flood Control Analysis
		H-V	US Geological Survey Flow Loss and Travel Time Studies
		H-VI	Environmental, Social, Cultural, and Recreational Resources
		H-VII	Design Details and Cost Estimates
		H-VIII	Drawdown Frequency and Yield Dependability Analyses
		H-IX	Bloomington Future Water Supply Storage Contract
		H-X	Novation Agreement
I	Outlying Service Areas		

*The Final Report for the Metropolitan Washington Area Water Supply Study consists of a Main Report, nine supporting appendices, and various annexes as outlined above. The Main Report provides an overall summary of the seven-year investigation as well as the findings, conclusions, and recommendations of the District Engineer. The appendices document the technical investigations and analyses which are summarized in the Main Report. The annexes provide detailed data or complete reports about individual topics contained in the respective appendices.

METROPOLITAN WASHINGTON AREA WATER SUPPLY STUDY

APPENDIX A

BACKGROUND INFORMATION AND PROBLEM IDENTIFICATION

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APPENDIX A

BACKGROUND INFORMATION AND PROBLEM IDENTIFICATION

INTRODUCTION

The Potomac River and its tributaries flow through a land filled with many legendary places - Harpers Ferry, Gettysburg, the Chesapeake and Ohio Canal, Mount Vernon and the Nation's capital - to mention only a few. The River has carried people and their commerce, furnished food to eat, and supplied water to drink. As development has progressed from the time of the early settlers, more and more people have come to depend on the River, both using and abusing its abundant resources.

The importance of the Potomac River, not only to its immediate neighbors but to the Nation as well, has been demonstrated by such events as the June 1976 Congressional hearings sponsored by Congressmen Herbert E. Harris and Gilbert Gude on the "State of the Potomac" and the oversight Hearings sponsored by Senator Mathias in October 1979. Although many studies have analyzed the water resources of the Potomac Basin and made recommendations concerning its development and use, until recently few positive actions had been taken to insure a dependable water supply for the Metropolitan Washington Area (MWA).

AUTHORITY

As a response to various reports and recommendations transmitted to the Congress concerning water resource planning in the Potomac River Basin, an entire section of the Water Resources Development Act of 1974 (Section 85 of Public Law 93-251, 7 March 1974) addressed the water supply issues relating to the MWA. Section 85-b(1) of P.L. 93-251 authorized the Metropolitan Washington Area Water Supply Study and directed the Chief of Engineers: 1) to make an investigation of the future water resource needs of the Metropolitan Washington Area and 2) to provide recommendations based on this investigation, and report to the Congress the results of the study together with the recommendations.

Section 85-b(3) further stipulated that the Chief of Engineers request the National Academy of Sciences-National Academy of Engineering to review and, by written report, comment upon the scientific basis for conclusions reached by the investigation of future water resource needs of the Metropolitan Washington Area. Section 85 of P.L. 93-251 is presented in its entirety in Figure A-1.

STUDY PURPOSE AND SCOPE

Simply stated, the purpose of the Metropolitan Washington Area Water Supply Study was to develop, analyze and recommend those alternative measures required to solve the MWA's immediate and long-term water supply problems. The findings of the study are intended as an aid to all levels of water resources managers for the evaluation of implementable, cost-effective and environmentally acceptable means to both manage the existing water supply systems and meet future water supply needs.

SECTION 85
WATER RESOURCES DEVELOPMENT ACT OF 1974
Public Law 93-251

SEC. 85. (a) The projects for Verona Dam and Lake, Virginia, and for Sixes Bridge Dam and Lake, Maryland, are hereby authorized substantially in accordance with the recommendations of the Secretary of the Army in House Document Numbered 91-343 as modified by the recommendations of the Chief of Engineers in his report dated July 13, 1973, except that such authorization shall be limited to the phase I design memorandum of advanced engineering and design, at an estimated cost of $1,400,000.

(b)(1) Prior to any further authorization of such Sixes Bridge Dam Project, the Secretary of the Army, acting through the Chief of Engineers shall (A) make a full and complete investigation and study of the future water resources needs of the Washington metropolitan area, including but not limited to the adequacy of present water supply, nature of present and future uses, the effect water pricing policies and use restrictions may have on future demand, the feasibility of utilizing water from the Potomac estuary, all possible water impoundment sites, natural and recharged ground water supply, wastewater reclamation, and the effect such projects will have on fish, wildlife, and present beneficial uses, and shall provide recommendations based on such investigation and study for supplying such needs, and (B) report to the Congress the results of such investigation and study together with such recommendations. The study of measures to meet the water supply needs of the Washington metropolitan area shall be coordinated with the Northeastern United States water supply study authorized by the Act of October 27, 1965 (79 Stat. 1073).

(2) The Secretary of the Army, acting through the Chief of Engineers, shall undertake an investigation and study of the use of estuary waters to determine the feasibility of using such waters as a source of water supply and is authorized to construct, operate, and evaluate a pilot project on the Potomac estuary for the treatment of such waters at an estimated cost of $6,000,000. The Secretary of the Army, acting through the Chief of Engineers, shall report to the Congress on the results of such project within three years after commencement of operation of such project and such report shall include the results of two years testing at the pilot project for the treatment of water from the Potomac estuary.

(3) The Secretary of the Army, acting through the Chief of Engineers, shall request the National Academy of Sciences-National Academy of Engineering to review and by written report comment upon the scientific basis for the conclusions reached by the investigation and study of the future water resource needs of the Washington metropolitan area and the pilot project for the treatment of water from the Potomac estuary. Such review and written report shall be completed and submitted to the Congress within one year following the completion of both the Corps of Engineers report on the future water resource needs of the Washington metropolitan area and the report on the results derived from the pilot project for the treatment of water from the Potomac estuary. Completion of such review and written report by the National Academy of Sciences-National Academy of Engineering shall be a condition of further authorization of such Sixes Bridge Dam Project.

(4) The Secretary of the Army is authorized to enter into appropriate arrangements with the National Academy of Sciences-National Academy of Engineering for the purpose of this subsection.

(c) There is authorized $1,000,000 for the purposes of carrying out the provisions contained in paragraph (3) of subsection (b).

FIGURE A-1

Recognizing the study's lengthy and complex nature at the outset, the study was designed and managed as a two phased effort. The first phase addressed the immediate short-range water supply problems with the primary goal being to solve those problems through more efficient use of existing water supplies. A Progress Report was published in August 1979 which presented the evaluation of the short-range problems and solutions to the MWA's water supply problems. Since 1979 the study has concentrated on the second phase of the investigation dealing with potential long-range water supply problems. The goal of the study's second phase was to determine the feasibility of providing additional sources of raw water in order to meet long-term needs.

STUDY AREA

As shown in Figure A-2 the MWA straddles the Potomac River near the fall line where the freshwater portion of the river empties into the tidal estuary. For the purposes of the MWA Water Supply Study, the Metropolitan Washington Area was defined as shown in Figure A-3 to include: the counties of Arlington, Fairfax, Loudoun, and Prince William, and the independent cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park in Virginia; the counties of Charles, Montgomery, and Prince Georges in Maryland; and the District of Columbia. This area is identical to the Washington, D.C. Standard Metropolitan Statistical Area (SMSA) which the U.S. Bureau of Census employs for planning and estimating purposes.

Total surface area within the MWA includes almost 3000 square miles - 2800 square miles of land and 200 square miles of water. The MWA is drained primarily by the Potomac River and its various tributaries with the exception of the northeastern edge which is drained by the Patuxent River which flows directly into the Chesapeake Bay.

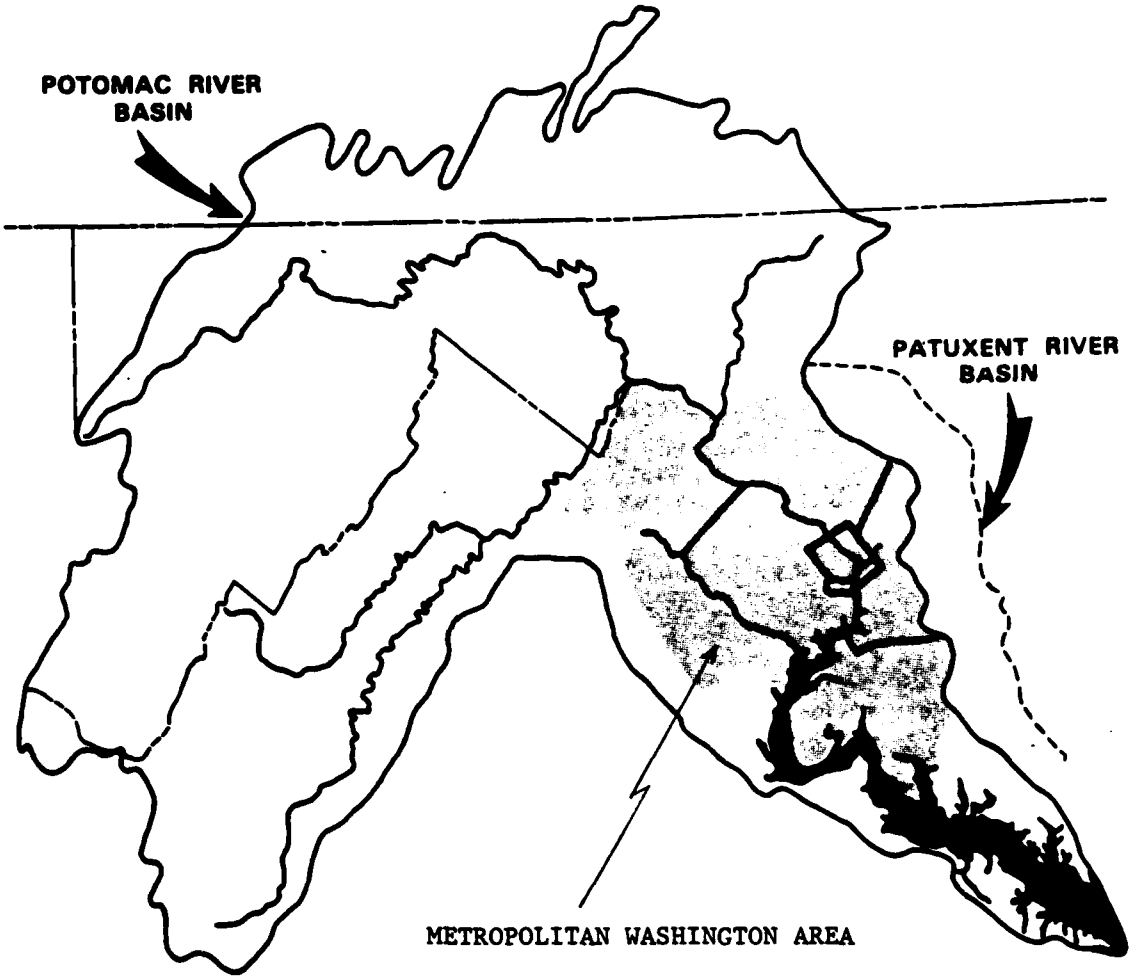
STUDY PROCESS AND COORDINATION

The planning process used for the MWA Water Supply Study followed the Corps of Engineers' guidelines for implementing the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources. This planning process was implemented in each of two study phases: an early-action phase and a long-range phase. The early-action phase culminated in the presentation of several plans to meet the immediate needs of the MWA. The long-range phase analyzed previously unexamined alternatives to determine their feasibility for reducing needs or providing additional supply. During each of these phases, six planning tasks were executed which, through an iterative process, narrowed the range of alternatives considered and analyzed. For a detailed description of this process refer to Appendix B - Plan Formulation, Assessment and Evaluation.

Several committees were used to assist the District Engineer and study team in conducting the MWA Water Supply Study. The four committees - the Federal-Interstate-State-Regional Advisory Committee (FISRAC), the Water Resources Planning Board (WRPB), a Water Supply Advisory Committee (WSAC), and a Citizens Task Force (CTF) - were used as the means for participation by the "involved public" and "decision-makers." Additionally, two other groups, an Interagency Review Panel (IRP) and the National Academy of Sciences-National Academy of Engineering, advised the District Engineer on policy and scientific aspects of the MWA Water Supply Study. For a description of the coordinating committees, refer to Appendix C - Public Involvement.

FIGURE A-2

LOCATION OF METROPOLITAN WASHINGTON AREA



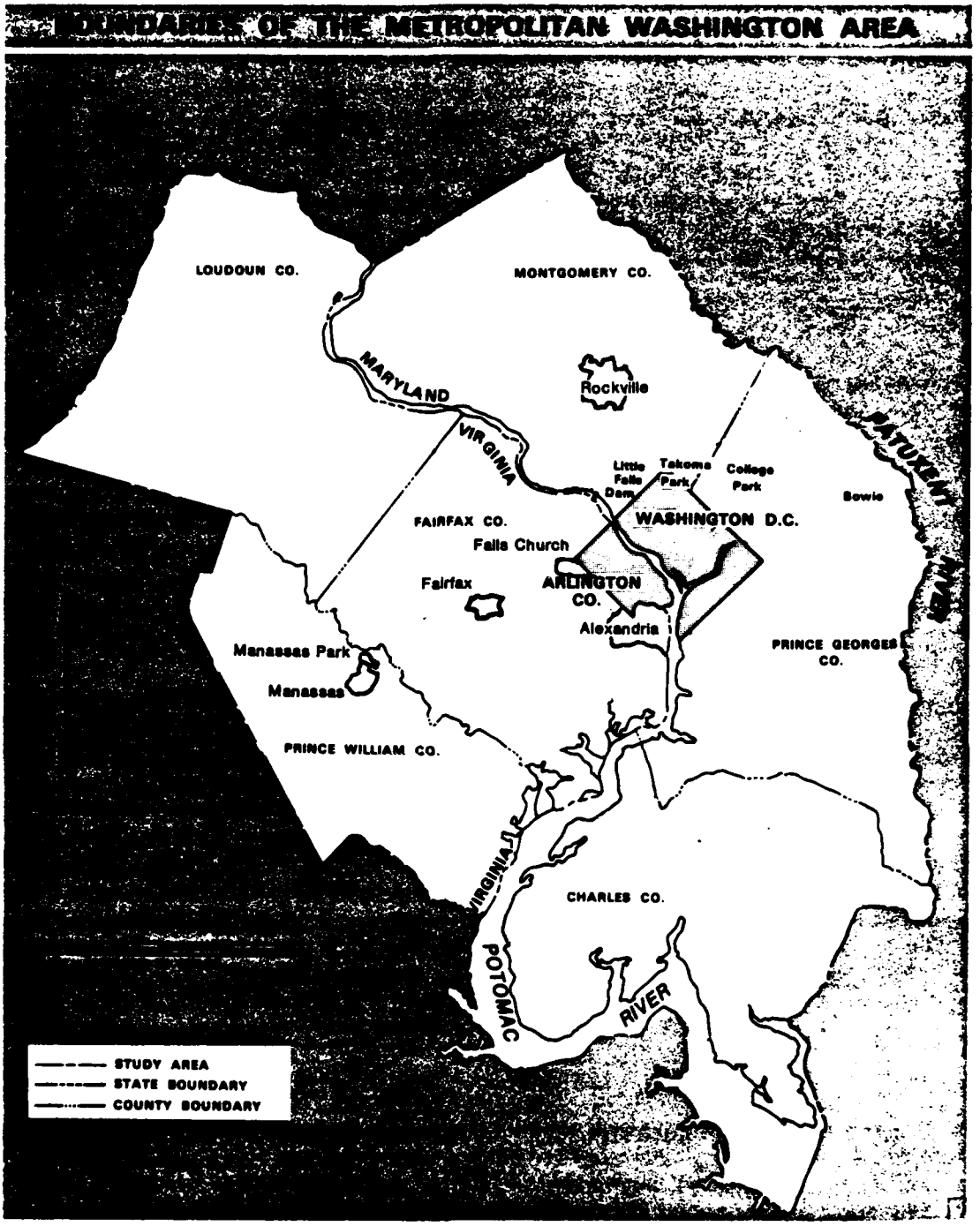

BOUNDARIES OF THE METROPOLITAN WASHINGTON AREA
LOUDOUN CO.
MONTGOMERY CO.
MARYLAND
VIRGINIA
Rockville
PATUXENT
Little Falls Dam
Takoma Park
College Park
Bowie
FAIRFAX CO.
WASHINGTON D.C.
Falls Church
Fairfax
ARLINGTON CO.
Alexandria
PRINCE GEORGES CO.
Manassas Park
Manassas
PRINCE WILLIAM CO.
VIRGINIA
CHARLES CO.
POTOMAC
RIVER
STUDY AREA
STATE BOUNDARY
COUNTY BOUNDARY

FIGURE A-3

PURPOSE OF APPENDIX

This Appendix provides a brief description of the various activities and characteristics of the MWA that were relevent considerations in this Study effort. Recent water resources planning history and current planning activities in the Potomac River Basin are identified. Natural and socio-economic resources including a section on growth and development are also discussed. By presenting these and other factors relating to the existing conditions in the MWA, the reader will have a familiarization with the study area that will aid in the presentation and development of the water supply problem.

PLANNING BACKGROUND

The history of water resources development in the Potomac River Basin includes many Congressional authorizations for individual studies, projects, and planning reports, dating from the 1800's through the present. Prior to the 1950's, early reports concentrated primarily on the problems of navigation, flood control, and hydropower. However, against the background of rapid growth following World War II, and the ensuing technological, economic, social, and political changes of that period, there has been increasing awareness throughout the United States of the problem of water management to support this growth. The purpose of this section is to outline the history of the Corps of Engineers involvement in water resources management studies of the Potomac Basin. Table A-1 summarizes these activites.

POTOMAC RIVER BASIN REPORT

In July 1955, Congress authorized a study of the North Branch Potomac River for the purposes of flood control, low flow augmentation, water quality control, and water supply. Later, in January 1956, a Congressional resolution was passed requesting the Corps of Engineers to prepare a comprehensive plan for the entire Potomac River Basin. These studies and reports are described in the following sections.

NORTH BRANCH REPORT (1961)

In April 1961, the District Engineer submitted his report for the North Branch Potomac River. This interim report, published prior to completion of the comprehensive basinwide study, was prepared for early consideration of the needs of the North Branch area. The advance studies and recommendations in the North Branch Report were to permit an early start on needed improvements which could be readily integrated into the comprehensive study for the entire basin.

The major recommendation of the North Branch Report was for construction of the Bloomington Lake project just upstream of Bloomington, Maryland, on the North Branch Potomac River. The Bloomington Lake project was subsequently authorized by Congress in October 1962 for the purposes of low flow augmentation, water quality control, flood control, and recreation. Following detailed design and preparation of plans and specifications, construction began in 1971 and the project was operationally complete in July 1981.

TABLE A-1

SUMMARY OF CORPS INVOLVEMENT IN THE POTOMAC BASIN

Study	Authorization	Completion	Major Recommendations
North Branch Potomac River Study	July 1955	April 1961	Construction of Bloomington Lake Project
Potomac River Study	January 1956	February 1963	1. 418 headwater Basin reservoirs for flood control, water supply, water quality control, recreation. 2. 16 major reservoirs including previously authorized Bloomington Lake.
Report of the Board of Engineers for Rivers and Harbors	-----	December 1963	Reanalysis of need for Seneca project on main stem Potomac.
Report of Chief of Engineers	-----	February 1969	1. Construction of six major reservoirs to meet immediate needs in the Potomac Basin. 2. Assume leadership role in investigating the Potomac Estuary as a supplemental source.
Report of the Secretary of the Army	-----	June 1970	Prompt Congressional authorization of Sixes Bridge and Verona projects.
Potomac River Basin Water Supply - An Interim Report 1973	1972	May 1973	1. Authorization and construction of Verona and Sixes Bridge. 2. Authorization and Construction of a prototype Advanced water treatment plant. 3. Continuing studies.

BALTIMORE DISTRICT ENGINEER'S REPORT (1963)

The 1956 Congressional resolution noted earlier requested the Corps of Engineers to review the earlier reports on the Potomac River "...with a view to preparation of a comprehensive plan for control of floods and the development and conservation of the water and related resources of the basin, with emphasis on present and future needs of water supply and pollution abatement." (Resolution, Committee on Public Works, United State Senate, adopted 26 January 1956.) This resolution and several other authorizations for water resource projects in the Potomac Basin including the North Branch Study, provided the basis for the comprehensive Potomac River Basin Study which was initiated later in 1956.

A subsequent Senate resolution in 1959 placed additional emphasis on water supply planning by directing the Corps of Engineers to review the earlier report "...with a view to preparation of a plan for flood control, recreation, and development and conservation of municipal and industrial water supply and pollution abatement." (Resolution, Committee on Public Works, United States Senate, adopted 6 July 1959 amended 27 April 1960.)

Alternate Plans for specific areas (such as the North Branch above Cumberland, and water supply for the MWA) and four preliminary basinwide plans were developed from the final group of projects. This process of plan formulation was performed through the combined efforts of the participating agencies. The four basinwide plans were then analyzed at a survey scope level of detail with one of the plans eventually being eliminated because of unacceptable geologic conditions at several of the major reservoir sites. The final three basinwide plans were labeled as: (1) the Main Stem and Upper Basin Plan; (2) the Major Tributary Plan; and (3) the Upper Basin Plan.

From the review of the basinwide plans by cooperating agencies and through a series of public meetings, a plan was selected for recommendation in the District's report on the Potomac River Basin Study published in February 1963. The important features of the basinwide plan recommended by the District Engineer were as follows:

- Treatment of all wastes entering the Basin's streams by 2010 to an average of 85 percent effectiveness throughout the Basin and 90 percent in the MWA;
- A total of 418 headwater reservoirs for flood control, water supply, quality control, and recreation;
- Sixteen major reservoirs including the Bloomington project already authroized under the Flood Control Act of 1962 in response to the early report of April 1961 for the North Branch Potomac River;

- Three small flood control projects already authorized under Public Law 685 (also in response to the April 1961 report for the North Branch);

- Land management and conservation measures to reduce erosion and rapid localized runoff.

The findings of the District Engineer further suggested that the plan as formulated in the Report "...be adopted as the Comprehensive Plan for Development of the water resources of the Potomac River Basin; that the projects in the Comprehensive Plan designated as Royal Glen, Chambersburg, Staunton, Sixes Bridge, West Branch, Brocks Gap, Winchester, and Seneca be authorized for construction for the purposes of flood control, water supply, water quality control, and recreation as applicable...and that the projects in the Comprehensive Plan designated as Licking Creek, Mount Storm, Town Creek, North Mountain, Savage II, Back Creek, and Tonoloway Creek be authorized for site preservation." Figure A-4 shows the location of these projects within the Potomac River Basin. The report and recommendations were forwarded to the Board of Engineers for Rivers and Harbors in April 1963.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS (1963)

The Board of Engineers for Rivers and Harbors (BERH) reviewed the findings and recommendations of the Potomac River Basin Study and conducted a public hearing in Washington, D.C., in September 1963. Based on its review as well as the comments of others, the BERH recommended that the plan, as formulated by the District Engineer, be adopted as the Comprehensive Plan for development and beneficial uses of the water resources of the Potomac River Basin.

One significant item of future importance was included in the BERH's report to the Chief of Engineers: specifically, that the Seneca project on the main stem of the Potomac River upstream of the District of Columbia be subject to more detailed studies prior to any construction at the site. As stated in the BERH's recommendations concerning the Potomac River Basin Study,

> ...prior to the construction stage for the Seneca project detailed analyses be made of the complex water quality and tidal phenomena of the Potomac estuary, to determine whether the project is still the best overall means of fulfilling all of the water resources needs, taking into account the advances in development of waste treatment, the conversion of saline water, and other alternative means which may be available at that time.

The report prepared by the BERH was forwarded to the Chief of Engineers in December 1963.

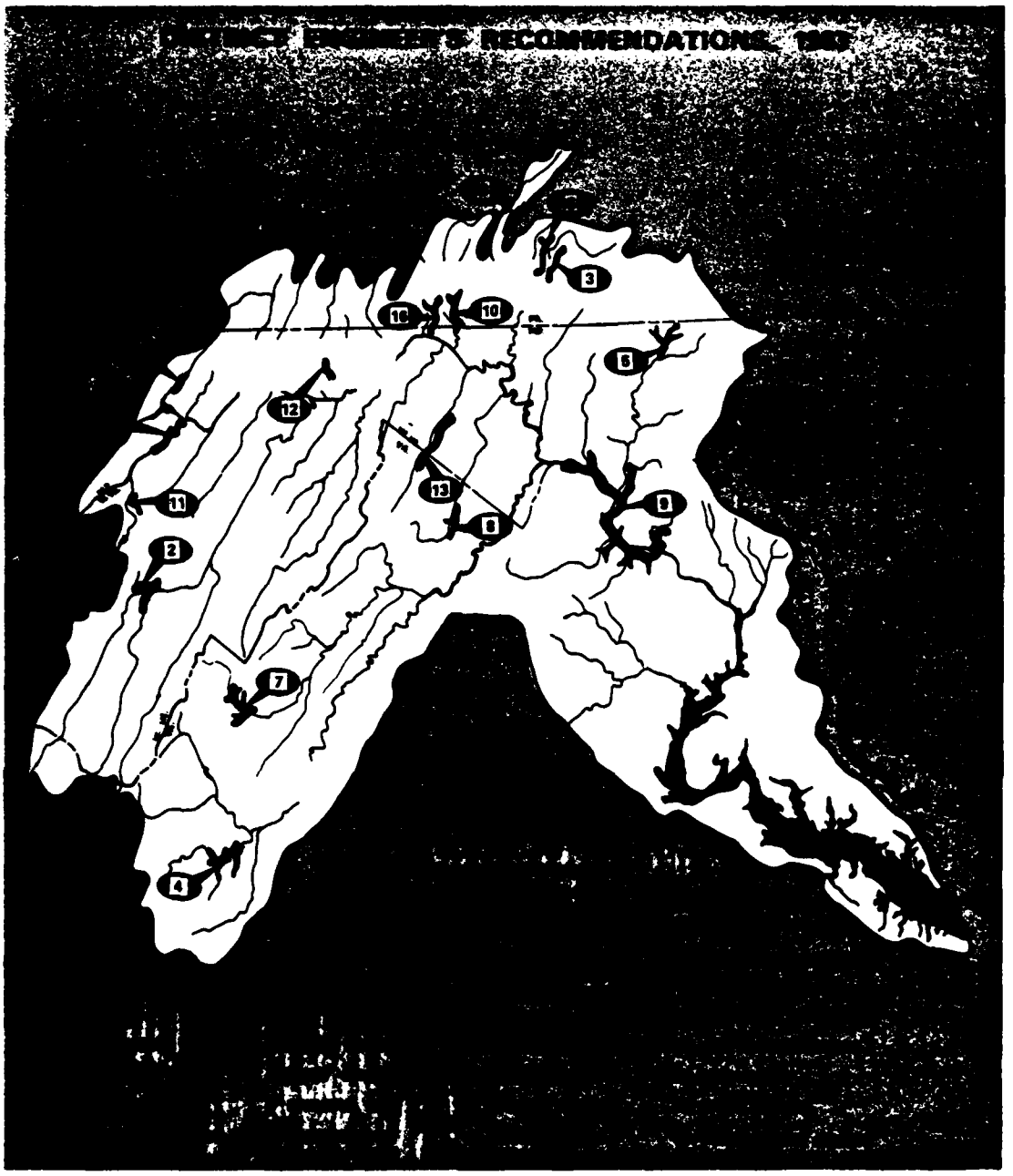


FIGURE A-4

REPORT OF THE CHIEF OF ENGINEERS (1969)

Following completion of the reports of the District Engineer and the Board of Engineers for Rivers and Harbors, the Chief of Engineers prepared a report which was furnished to interested state and Federal agencies in 1964 for review and comment. During the review period, the President, in his Message on Natural Beauty in February 1965, asked that the Potomac serve as a model of scenic and recreational values for the entire country.

A Federal Interdepartmental Task Force on the Potomac (composed of representatives of the Departments of Agriculture; Army; Health, Education, and Welfare; and Interior) was created to accomplish this new planning effort with the cooperation of the Potomac River Advisory Committee (composed of representatives of the four states and the District). These two groups prepared and submitted the Potomac Interim Report to the President in January 1966. The report offered a Federal plan for the protection and enhancement of the scenic and recreational resources of the Potomac Basin. The interim report was later published as The Nation's River in October 1968 and transmitted to the President.

During this period, the Chief of Engineers reviewed the Potomac River Basin Study in light of the increasing dependence on the Potomac River system for municipal and industrial water supply, especially within the MWA. Six major reservoirs (in addition to Bloomington) were identified as an initial system of projects to meet the growing demands for water supply, water quality control, and flood control while complementing the President's objective of making the Potomac Basin a model of scenic and recreational values.

These six projects were viewed as providing the maximum opportunity for solving the immediate water supply and related needs of the Basin. Planning for the less immediate or long-range needs was left for a future time when technological advances might be able to provide dependable alternative solutions which were not then available. The six projects, listed in order of priority for construction and shown on Figure A-5, were as follows:

a. Sixes Bridge, Frederick and Carroll Counties, Maryland, and Adams County, Pennsylvania.

b. Verona (Staunton), Augusta County, Virginia.

c. Town Creek, Allegany County, Maryland.

d. North Mountain, Berkeley County, West Virginia, and Frederick County, Virginia.

e. Sideling Hill, Allegany and Washington Counties, Maryland.

f. Little Cacapon, Hampshire County, West Virginia.

A public meeting concerning this proposed initial system of six reservoirs was held in Winchester, Virginia, in March 1968. State and local officials voiced reservations about the potential environmental impacts and the project costs.

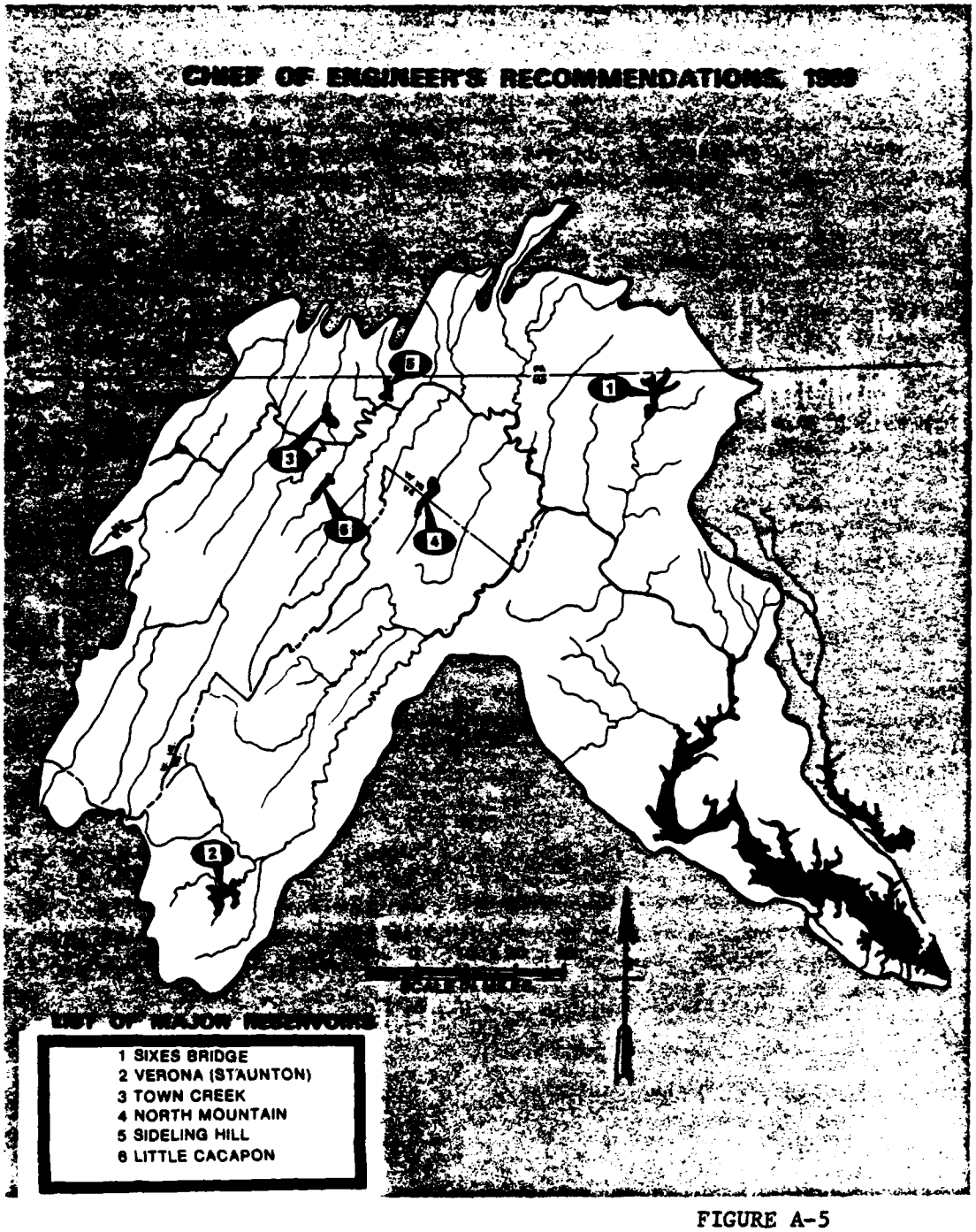

CHIEF OF ENGINEER'S RECOMMENDATIONS, 1968
LIST OF MAJOR RESERVOIRS
1 SIXES BRIDGE
2 VERONA (STAUNTON)
3 TOWN CREEK
4 NORTH MOUNTAIN
5 SIDELING HILL
6 LITTLE CACAPON

FIGURE A-5

With regard to the long-range needs, the Chief of Engineers' report also noted the growing concern about the future supply for the MWA. Solutions such as reclamation of wastewater, conversion of saline water, and use of the Potomac Estuary were recognized as possible alternatives to reservoir storage, provided that continued research could resolve the problems of feasibility and acceptability. Because of the desires of concerned interests to limit project considerations, those projects that were needed to satisfy the immediate water supply needs and to preserve maximum flexibility for future planning took precedence over other elements of the Comprehensive Plan. In his report to the Secretary of the Army in February 1969, the Chief of Engineers recommended construction of the initial system of six reservoirs to meet the immediate needs in the Potomac Basin. Further planning on a long-range scale was delayed to such time as scientific research advanced to the degree necessary for proper evaluation of other alternatives for the purpose of water supply.

The Chief of Engineers did, however, suggest that the Corps of Engineers assume a leadership role in the investigation of the Potomac Estuary as a supplemental source of water supply. In view of the highly complex nature of the estuary and the need for a better understanding of the numerous variables involved in its safe use, the Chief of Engineers concluded that several years of study would be required and should be initiated as soon as possible. The Chief of Engineers further suggested that the study be accomplished in cooperation with other Federal agencies, the State of Maryland, the Commonwealth of Virginia, the District of Columbia, and the Metropolitan Washington Council of Governments.

REPORT OF THE SECRETARY OF THE ARMY (1970)

Subsequent to the preparation of the report of the Chief of Engineers, further re-evaluations were made. Using the then current interest rate and the standard methods of cost allocation for water supply, only two projects - Sixes Bridge and Verona (Staunton) - were found to meet the standards and criteria necessary for authorization by Congress. The Sideling Hill and Little Cacapon projects were marginal in economic justification and were not strongly supported by the affected states. The North Mountain and Town Creek projects had been formulated largely for the purpose of recreation in consonance with the President's objective of making the Potomac River a model of scenic and recreational values. However, there was no approved recreation plan for the entire area, and the matter was submitted for further review by the Secretary of the Interior. Authorization of the North Mountain and Town Creek projects was not recommended for these reasons.

The Secretary of the Army considered it essential that "...the delay in the development of a satisfactory recreation plan for the Basin not further delay projects which are urgently needed to provide an adequate interim water supply for the Washington area." Accordingly, in his letter of transmittal to the Congress, the Secretary of the Army recommended prompt Congressional authorization of the Sixes Bridge and Verona projects as shown on Figure A-6.

The letter of transmittal also expressed a belief that further measures should be undertaken to assure a satisfactory water supply for the MWA. Limited emergency use of the estuary, expedited construction of the Bloomington project, and authorization and construction of the Sixes Bridge and Verona projects would provide only a marginal interim solution, but would be an essential first step. The development of a more adequate and complete program of reservoir construction and other measures would be necessary for a long-term solution to water supply problems.

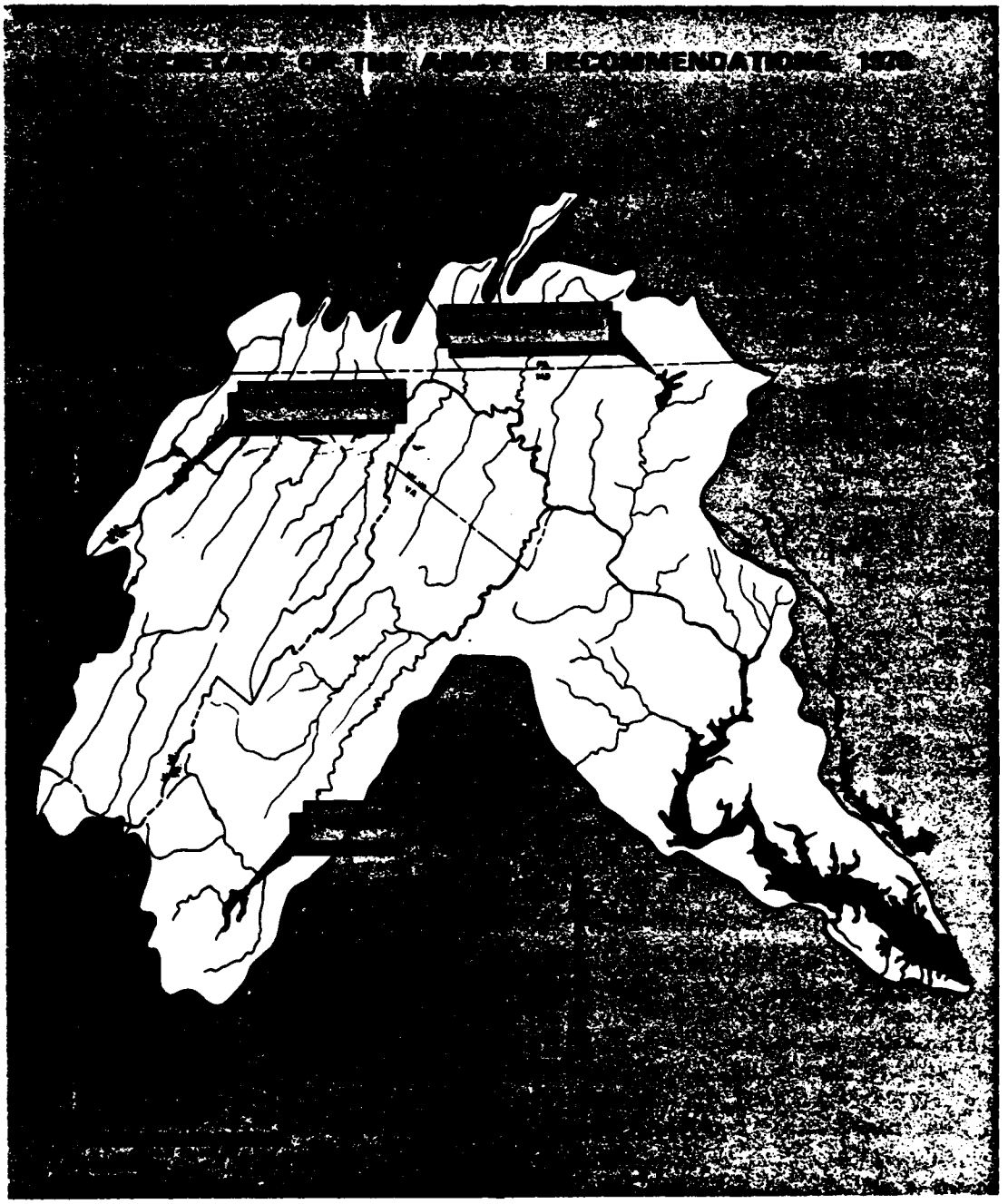


FIGURE A-6

POTOMAC RIVER BASIN WATER SUPPLY - AN INTERIM REPORT (1973)

In reviewing the Secretary of the Army's recommendations for the Sixes Bridge and Verona projects, the 1972 Congressional Conference Report on Senate Bill 4018 (Public Works on Rivers and Harbors) observed that benefits attributable to low flow augmentation for water quality were no longer acceptable under the recently passed Federal Water Pollution Control Act Amendments of 1972. Because both the Verona and Sixes Bridge projects, as formulated in the Chief of Engineers' Report in 1969 included substantial benefits for low flow augmentation, the Conferees directed the Secretary of the Army to reformulate both projects without the benefits for low flow augmentation, and to resubmit the projects to Congress by June 1973.

In order to accomplish this task, the water supply problems in the Potomac River Basin were evaluated with special emphasis on the MWA. The reformulated Sixes Bridge and Verona projects were also compared with alternative water supply concepts to insure that they were still the best first elements of a long-range water supply plan. Alternatives were also examined which would be needed, in addition to the Sixes Bridge and Verona projects, to insure continuing adequate water supply beyond the time for which the two projects would be sufficient.

The results of the reformulation process were summarized in the May 1973 document titled Potomac River Basin Water Supply - An Interim Report and were transmitted to Congress in July 1973. Three major recommendations were made in this report: (1) authorization and construction of the reformulated Sixes Bridge and Verona projects for the purposes of water supply, recreation, and stream enhancement; (2) authorization and construction of a prototype advanced water treatment plant (nominal capacity of 1 MGD) to test the feasibility of using the Potomac Estuary as a permanent supplemental water supply source for the MWA; and (3) that continuing studies be made by the Secretary of the Army in cooperation with the affected interests with a view to preparing practicable and acceptable plans for meeting future water demand in the MWA.

NORTHEASTERN UNITED STATES WATER SUPPLY STUDY (1977)

The Corps of Engineers was also involved in water supply planning for the MWA through its Northeastern United States Water Supply (NEWS) Study. The NEWS Study was authorized in October 1965 by P.L. 89-298 as a response to the mid-1960's drought which plagued the northeastern United States. The purpose of the NEWS Study was to prepare a coordinated general plan for essential water supply development in the northeast and to recommend to Congress an action program for solving the problems.

During the conduct of the NEWS Study, the MWA was identified as one of three major areas in the northeast with critical water supply problems. Planning efforts by the NEWS Study for the MWA paralleled the reformulation of Sixes Bridge and Verona in the Potomac River Basin Water Supply - An Interim Report. While the reformulation report dealt mainly with two reservoir projects identified for early action, the NEWS-MWA Study considered a more comprehensive range of solutions for the MWA's water supply problems. Alternative projects consisted of raw water interconnections, local impoundments, upstream reservoirs, use of groundwater, use of estuary water, indirect use of treated wastewater effluent, and land application of wastewater. Various

programs, composed of different mixes of these projects, were then formulated for consideration by decision-makers. Future research needs for technologically advanced water supply projects such as the Pilot Estuary Water Treatment Plant on the Potomac River near the District of Columbia were also identified.

IDENTIFICATION OF THE WATER SUPPLY PROBLEM FOR NEWS

As identified by the NEWS-MWA Study, the water supply problem centered around the occasional low flows of the Potomac River, restricting its ability to furnish adequate water supply for the MWA. Demand on the Potomac River was as high as 448 million gallons per day (mgd) in the summer of 1974; but the observed low flow in the River was 388 mgd in the summer of 1966. It was concluded that if these events had occurred simultaneously, the MWA would have experienced an extreme drought as the demand of the MWA would have exceeded the available water supply. Since 1971, the demand on the Potomac River has exceeded the observed one day low flow over 80 times. For these reasons, the NEWS Study developed and examined programs to reduce water demand and increase the available water supply.

GOALS OF THE NEWS-MWA STUDY

The major goals set forth by the NEWS-MWA Study to insure adequate water supply were as follows:

a. To provide management plans that would be regional in scope, technically feasible, timely, efficient, reliable, flexible, equitable, environmentally acceptable, implementable, and cost effective.

b. To examine the feasibility of those aspects of wastewater management related to water supply.

c. To formulate the management programs as regional systems for the maximum overall benefit to the community or nation as a whole.

d. To present a set of practical and implementable programs with a background of detailed information which would help to narrow the range of choices for the most feasible course of action to solve the MWA's water supply problem.

PLANNING OBJECTIVES

With the above-mentioned goals in mind, six planning objectives were used by the NEWS Study to develop and analyze a range of potential water supply projects. These water supply planning objectives were defined as follows: low risk, low cost, flexibility, limited environmental impact, social and economic equity, and growth control. In addition, investigation and selection of water supply alternatives was based on the assumption of efficiently managing the variability of Potomac River flows. The flow in the Potomac River, the major source for water supply, was treated as a time variable problem which required a combined solution of balancing monthly demands with simultaneously-occurring peak demands of weekly (7 day) and daily (1 day) duration.

PROJECTS CONSIDERED BY THE NEWS STUDY

The NEWS Study initially investigated 21 types of projects for balancing water supply and demand in the MWA over a 50 year planning period from 1970 to 2020. These projects, listed in Table A-2, covered a wide spectrum of technologies and water management techniques. Many of these preliminary projects relied on advanced but not thoroughly tested or proven technologies, rather than on the more traditional approach involving regulation of the Potomac River using upstream reservoirs.

TABLE A-2

PROJECTS CONSIDERED BY THE NEWS STUDY

- Two-Pipe Systems
- Self-Contained Recycling
- Upstream Reservoirs
- Weather Forecasting and/or Modification
- Small Storage Tanks or Reservoirs
- Local Improvements
- Underground Reservoirs
- Desalting
- Raw Water Interconnections
- Collection of Urban Runoff
- Montgomery County and Occoquan Quarry Pits
- Pricing
- Finished Water Interconnections
- Groundwater Withdrawal
- Interbasin Transfers from the Susquehanna and Rappahannock Basins
- Indirect Reuse of AWT Effluent
- Seneca Dam
- Estuarine Water Supply
- Air-Conditioning Recirculation
- Industrial Reuse of Water
- Land Application of Secondary Treatment Effluent

PROJECTS ANALYZED BY THE NEWS STUDY

After the identification of the operational baseline projects and the initial screening of the full range of projects, seven distinct project types remained as planning alternatives for further analysis in the NEWS Study. These projects, listed in Table A-3, represented a wide range of technologies, costs, impacts, and operating characteristics. Brief descriptions of the basic structural and operating characteristics of the seven types of projects are presented in the following paragraphs.

TABLE A-3

PROJECTS ANALYZED BY THE NEWS STUDY

- Upstream Reservoirs
- Local Impoundments
- Raw Water Interconnections
- Groundwater Withdrawal
- Indirect Reuse of AWT Effluent
- Estuarine Water Supply
- Land Application of Secondary Treatment Effluent

Upstream Reservoirs

The upstream reservoirs considered in the NEWS Study were multi-purpose projects providing stream enhancement, recreation, local water supply, and regional water supply for the MWA. An upstream reservoir involves an impoundment of water on a tributary to the Potomac River as illustrated in Figure A-7. By allowing the flows of the tributary to accumulate, a lake would form behind the dam. In general, the water supply portion of the reservoir would be filled by natural inflows during the high flow months of the year. During the low flow months of drought years, previously assigned volumes of water would be released to increase the flow in the Potomac River. At all times, a minimum flow based on the historical out-flows in the tributary would be maintained downstream of the dam.

The operational life of a reservoir is considered to be 100 years, thus the amortized construction costs tend to be low. Annual operating costs are also low and remain relatively constant from year to year since the key form of energy used for water delivery is gravity. In addition to the Bloomington Lake which is now operational, the NEWS Study considered two other multi-purpose upstream reservoirs - Verona Lake and Sixes Bridge Lake.

Local Impoundments

Local impoundments, located within the boundaries of the MWA, would consist of a dam, lake, pump station, and pipeline, as illustrated in Figure A-8. These local impoundments would be located on minor tributaries to the Potomac River and could provide regional water supply and recreation. As flows in these tributaries were determined to be quite small and insufficient to fill the reservoir, these reservoirs could be filled each year by pumping (skimming) water from the Potomac River during periods of high flow. When needed, the stored water would be released to the tributary to augment flows in the Potomac River.

Because of their long life of 100 years, the annual construction costs of local impoundments tend to be low. Operating costs vary from year to year depending on how much water (pumping) is needed to fill the impoundments. The NEWS Study considered three sites for possible local impoundments: Catoctin Creek and Goose Creek in Loudoun County, Virginia; and the Little Monocacy River in Montgomery County, Maryland.

Raw Water Interconnections

Raw water interconnections are projects which would use existing offstream reservoirs in the MWA to store surplus flows to be used during drought periods. The interconnections considered by the NEWS Study would be used to offset short-term flow variations in the Potomac River, thereby facilitating more efficient management of water supplies in the MWA.

As illustrated in Figure A-9, a raw water interconnection would involve the pumping of surplus water from the Potomac River to existing offstream reservoirs for storage. During periods of low flow in the Potomac River, the stored water would be pumped back into the Potomac River for withdrawal by MWA water suppliers. However, the capital costs and operation and maintenance costs would be high in relation to water yield. The NEWS Study considered two raw water interconnection projects: use of the Patuxent River reservoir system and use of the Occoquan Creek reservoir system.

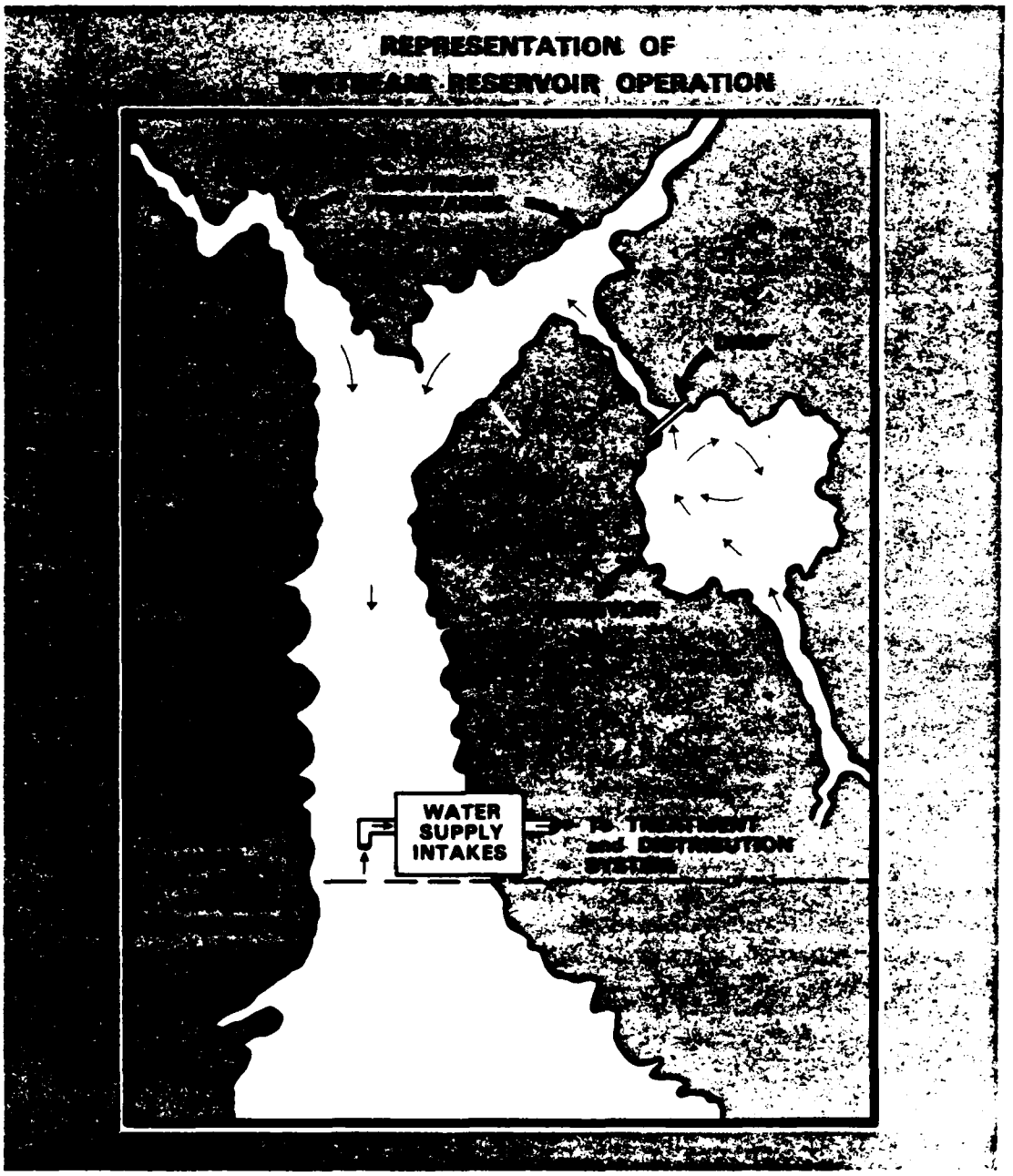

REPRESENTATION OF
RESERVOIR OPERATION
WATER
SUPPLY
INTAKES

FIGURE A-7

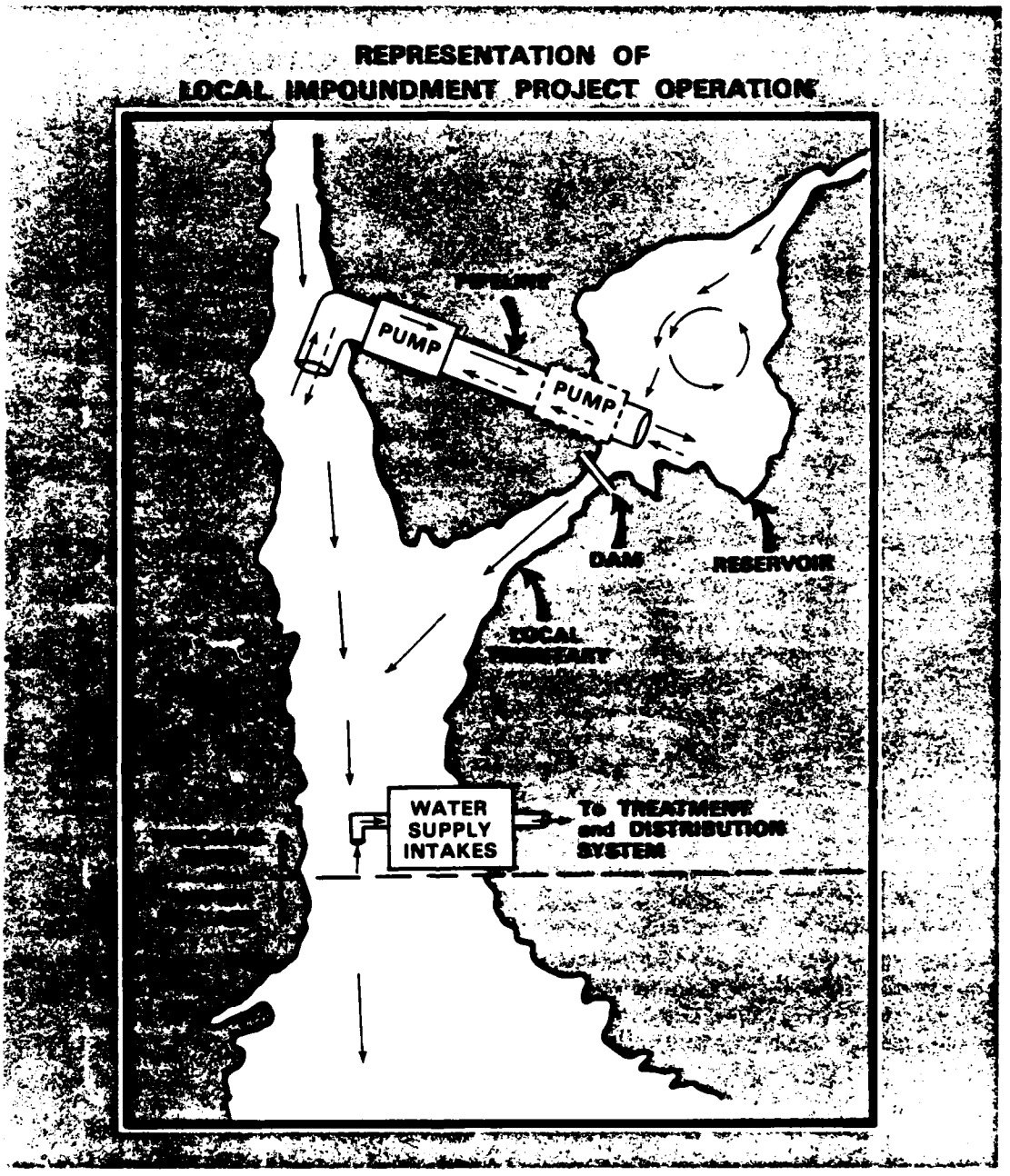

REPRESENTATION OF
LOCAL IMPOUNDMENT PROJECT OPERATION
PUMP
PUMP
DAM
RESERVOIR
WATER
SUPPLY
INTAKES
To TREATMENT
and DISTRIBUTION
SYSTEM

FIGURE A-8

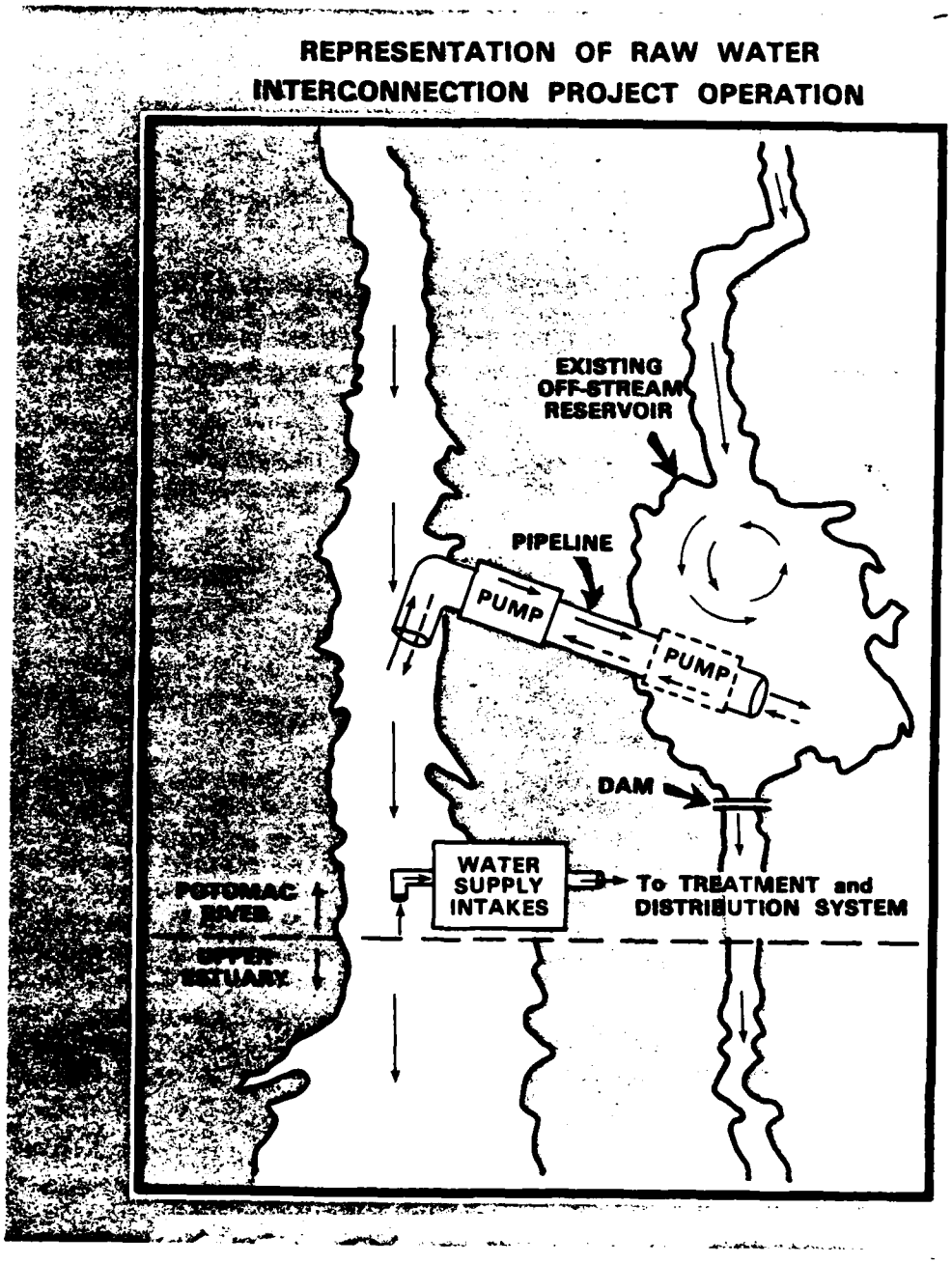

REPRESENTATION OF RAW WATER
INTERCONNECTION PROJECT OPERATION
EXISTING
OFF-STREAM
RESERVOIR
PIPELINE
PUMP
PUMP
DAM
WATER
SUPPLY
INTAKES
To TREATMENT and
DISTRIBUTION SYSTEM
POTOMAC
RIVER
UPPER
ESTUARY

FIGURE A-9

Groundwater Withdrawal

Two types of groundwater withdrawal projects were investigated in the NEWS Study: Upper Potomac River Basin well fields and Coastal Plain well fields. The primary difference between the two types of projects was the point of discharge of the pumped groundwater.

The upper basin well fields, tentatively located near Antietam Creek and Conococheague Creek in the Hagerstown Valley, would operate during the summer months of dry years to increase the average monthly flows in the Potomac River. As shown in Figure A-10, groundwater would be pumped into the Potomac River for gravity flow to the MWA water supply intakes. The Coastal Plain well fields, located in southern Anne Arundel County, could be operated to increase long-term water supply, but could also be operated to meet short-term peak water demands. Figure A-11 indicates that water from the Coastal Plain would be pumped directly to one of the water treatment plants serving the MWA.

Either project was determined to be moderately expensive. Both projects had the advantage of being able to construct the wells on an as-needed basis, thereby decreasing the initial capital cost. However, test drilling in both aquifers would be required to determine the safe yield before development of any well field could begin.

Indirect Reuse Of Advanced Waste Treament (AWT) Effluent

The purpose of considering these projects in the NEWS Study was to supplement the base flow of the Potomac River by making highly treated wastewater available for water supply reuse during drought conditions. As shown in Figure A-12, an AWT project would treat wastewater to an advanced degree and then pump the effluent to a discharge point in the Potomac River just downstream of the confluence with the Monocacy River. As the water moved toward the MWA water supply intakes, 30 miles downstream, the natural dilution, aeration, and instream purification processes would minimize potential health risks.

Three AWT projects of various sizes were studied as examples of indirect reuse of AWT effluent for the MWA. The AWT projects included: (1) a Montgomery County, Maryland, AWT plant, (2) a Fairfax County, Virginia, AWT plant, and (3) a Blue Plains (existing District of Columbia facility) Pumping Station-Pipeline. The Maryland and Virginia projects would include complete AWT plant construction and would serve to reduce the wastewater management problems in the MWA in addition to supplying water for indirect reuse. These AWT facilities would be large energy and chemical consumers and would produce large quantities of waste materials such as organic and chemical sludges. Additionally, there probably would be substantial public and professional concern about the safety of using AWT effluent as an indirect source of water supply.

Estuarine Water Supply

An estuarine water supply project consisting of a water intake on the upper Potomac Estuary, a treatment plant, and an effluent pump and pipeline was also considered. In the NEWS Study there were two types of estuarine water supply projects: Plant-Mix and River-Mix. Following treatment at an estuary treatment plant, the River-Mix

REPRESENTATION OF
HAGERSTOWN VALLEY WELL FIELDS OPERATION

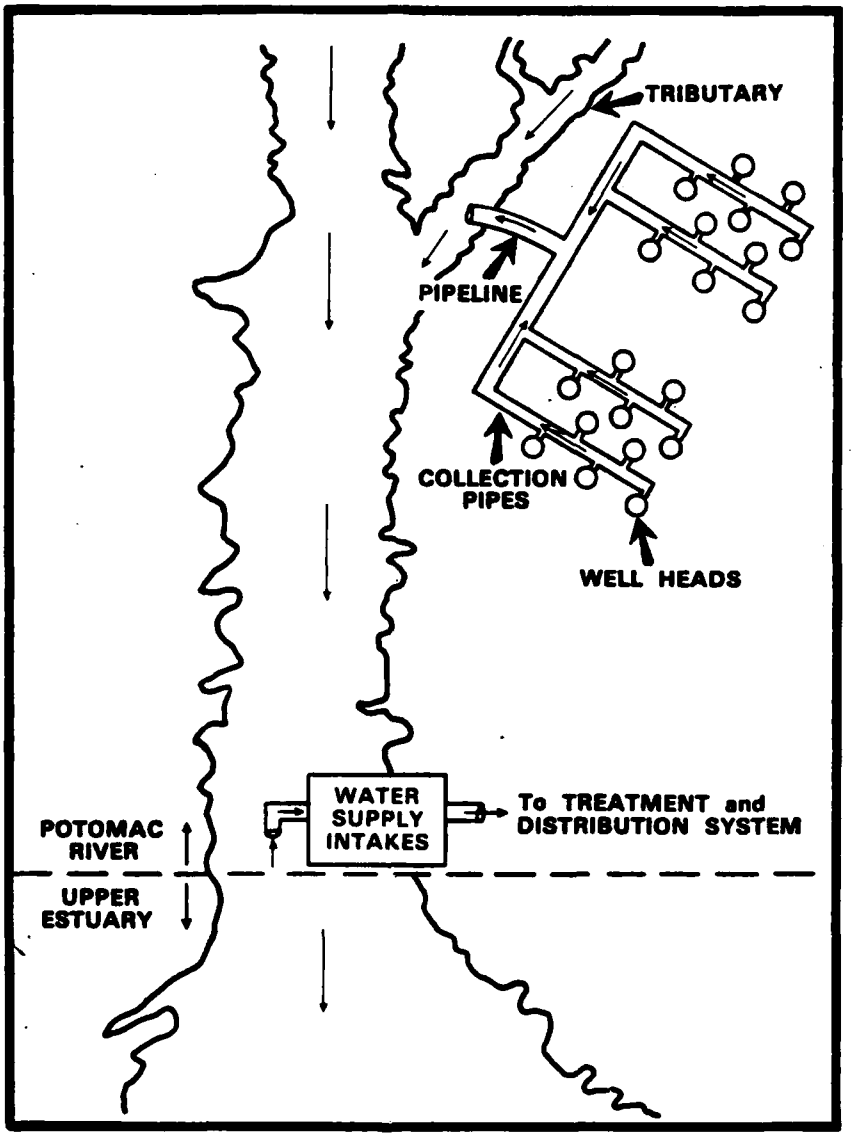


Figure A-10

REPRESENTATION OF MARYLAND COASTAL PLAIN WELL FIELDS OPERATION

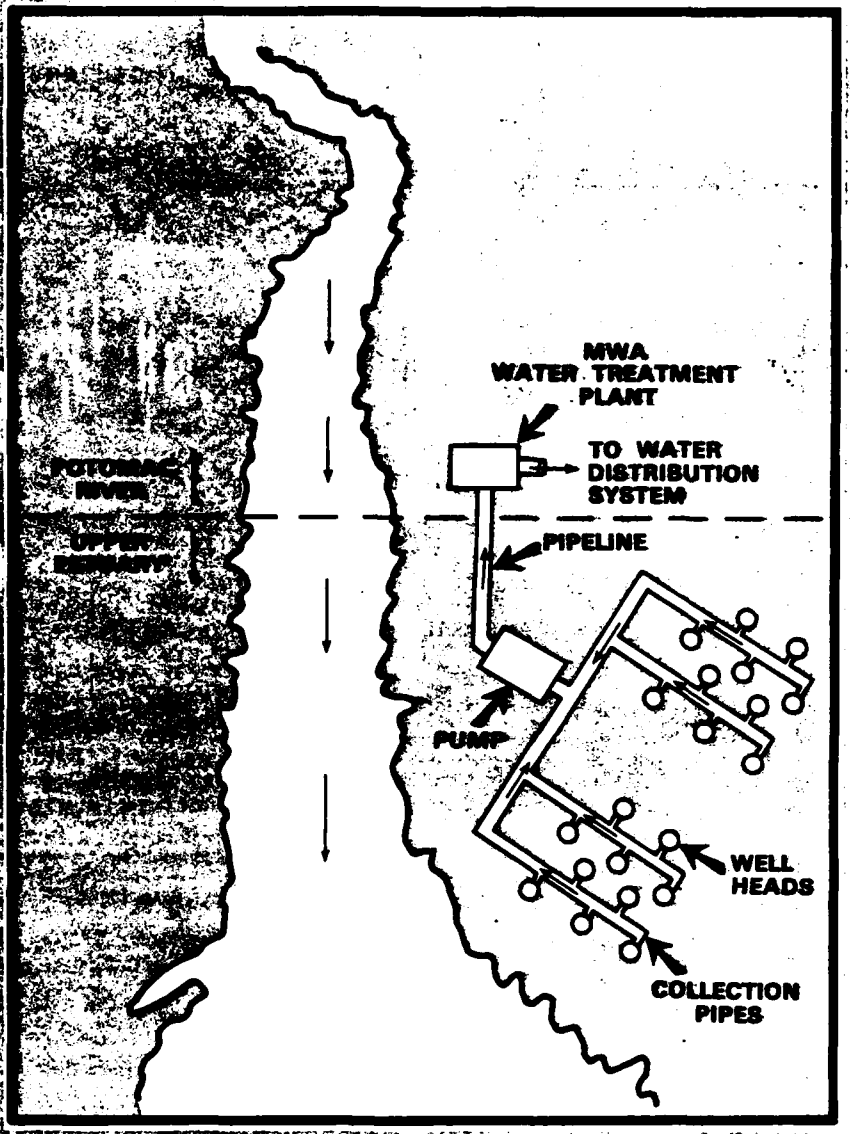


FIGURE A-11

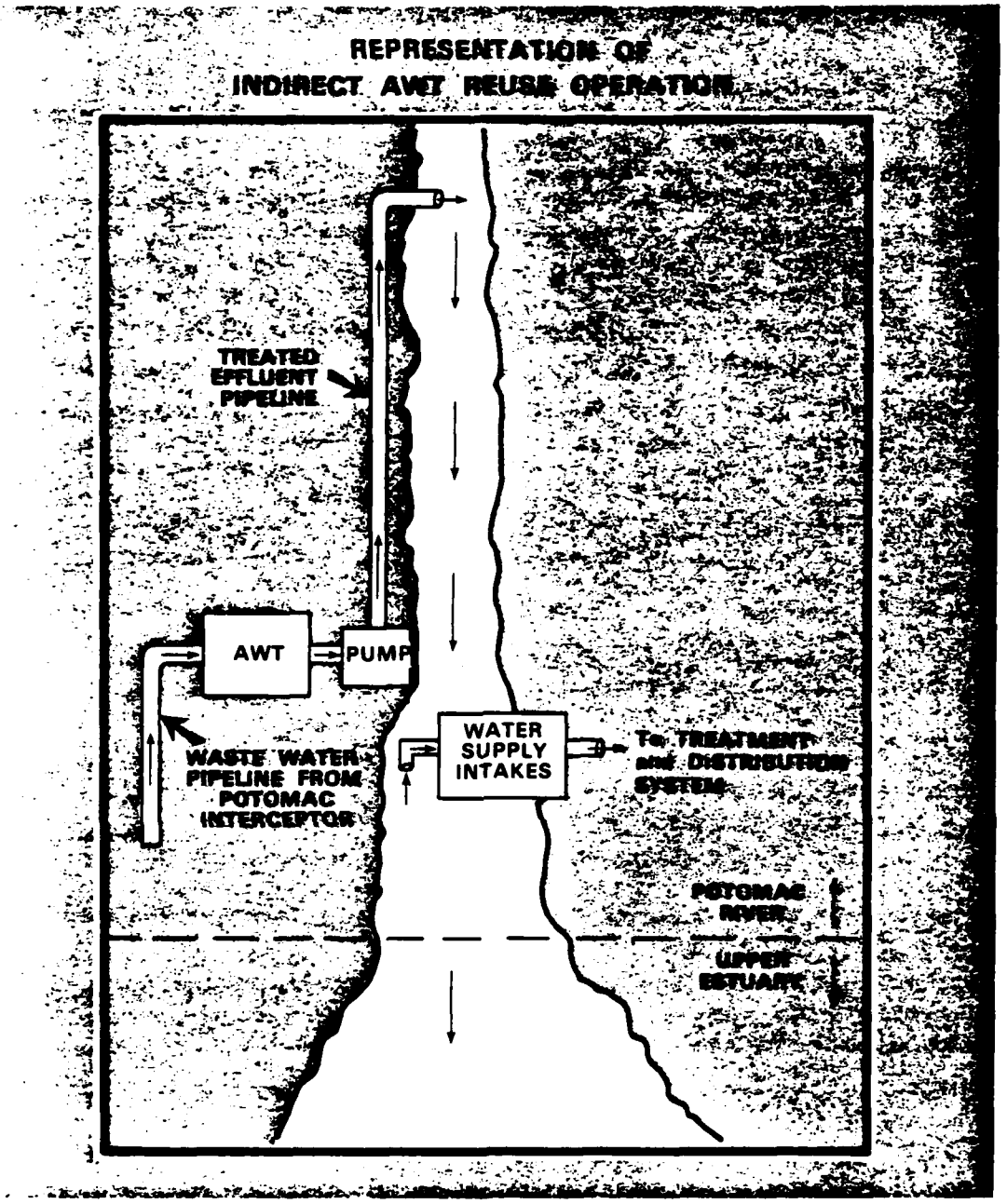

REPRESENTATION OF
INDIRECT AWT REUSE OPERATION
TREATED EFFLUENT PIPELINE
AWT
PUMP
WATER SUPPLY INTAKES
To TREATMENT and DISTRIBUTION SYSTEM
WASTE WATER PIPELINE FROM POTOMAC INTERCEPTOR
POTOMAC RIVER
UPPER ESTUARY

FIGURE A-12

alternative would discharge its treated estuary water to the Potomac River downstream of the Monocacy River for mixing with fresh water. In the Plant-Mix alternative, the treated estuary water would be discharged directly into the Dalecarlia Water Treatment Plant. Both alternatives are illustrated in Figure A-13.

It was determined that the estuarine water supply projects would be both capital and energy-intensive. Though they could be operated on an as-needed basis for use during dry periods, such plants would not be responsive to short-term peak water demands because of lengthy start-up times (4 to 6 weeks).

Land Application Of Secondary Treatment Effluent

Land application would be an alternative means to AWT facilities for recycling domestic wastewater. In essence, the land application process would consist of spreading effluent over agricultural land, employing the soil-plant complex to act as a natural advanced waste treatment medium, collecting the underdrainage, and discharging the resultant renovated water to the Potomac River upstream of the water supply intakes. Such a project would have the additional advantages of reducing the wastewater management problems in the MWA and increasing selected crop yields where the system would be located.

As shown in Figure A-14, the components of a land application project would be: (1) a wastewater source, (2) a pipeline and pump to transport the wastewater to the project areas, (3) a secondary wastewater treatment facility, (4) a storage reservoir to hold secondary effluent, and (5) the land application facility consisting of an application system, a large tract of land, a subsurface collection system, and an effluent pipe discharging into the Potomac River.

A land treatment project would operate continually during the growing season. The water supplied would add to the monthly safe yield of the Potomac River, but the project could not be altered to operate for short-term peak demands. Generally, such a project would be expensive to construct and operate, although some revenue could be gained through the sale of crops raised on the application area. However, land application of secondary treatment effluent does have the potential to solve both water supply and wastewater problems.

BASELINE PROJECTS AND PLANNING ASSUMPTIONS OF THE NEWS STUDY

Several assumptions were set forth by the NEWS Study prior to combining the alternatives into plans. The first assumption the NEWS Study made was that there would be two baseline projects completed before implementation of any alternative water supply plans. These two baseline projects are: (1) the Bloomington Lake Project, and (2) the Emergency Estuary Water Pumping Station.

Water supplies were assumed to be able to meet projected monthly average demands. (Monthly average demand is defined as the average rate at which water is demanded in a given month and is calculated by averaging the rate at which water is demanded for each day of the month.) Demand projections were reduced to reflect water use reductions through water saving fixtures and appliances of 1 mgd per year after 1975, for a total of 45 mgd by 2020.

REPRESENTATION OF ESTUARINE WATER SUPPLY OPERATION

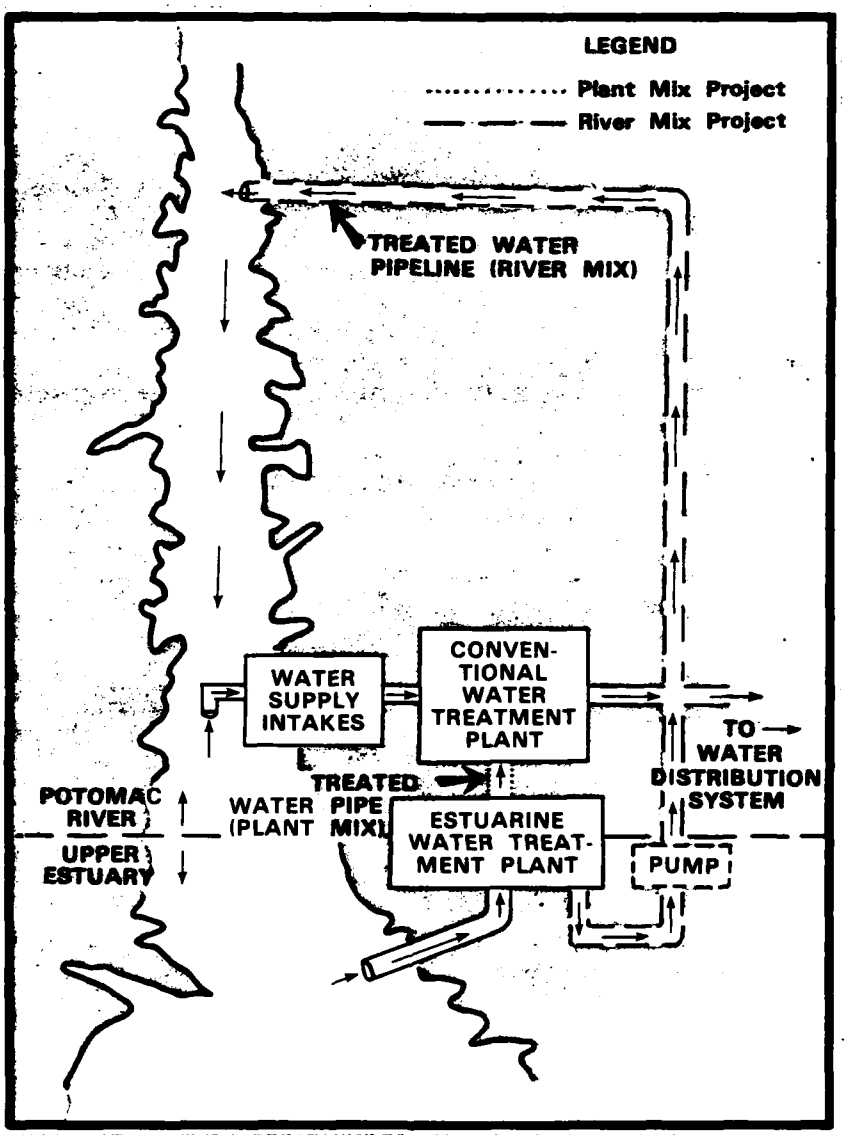


FIGURE A-13

REPRESENTATION OF
LAND APPLICATION OPERATION

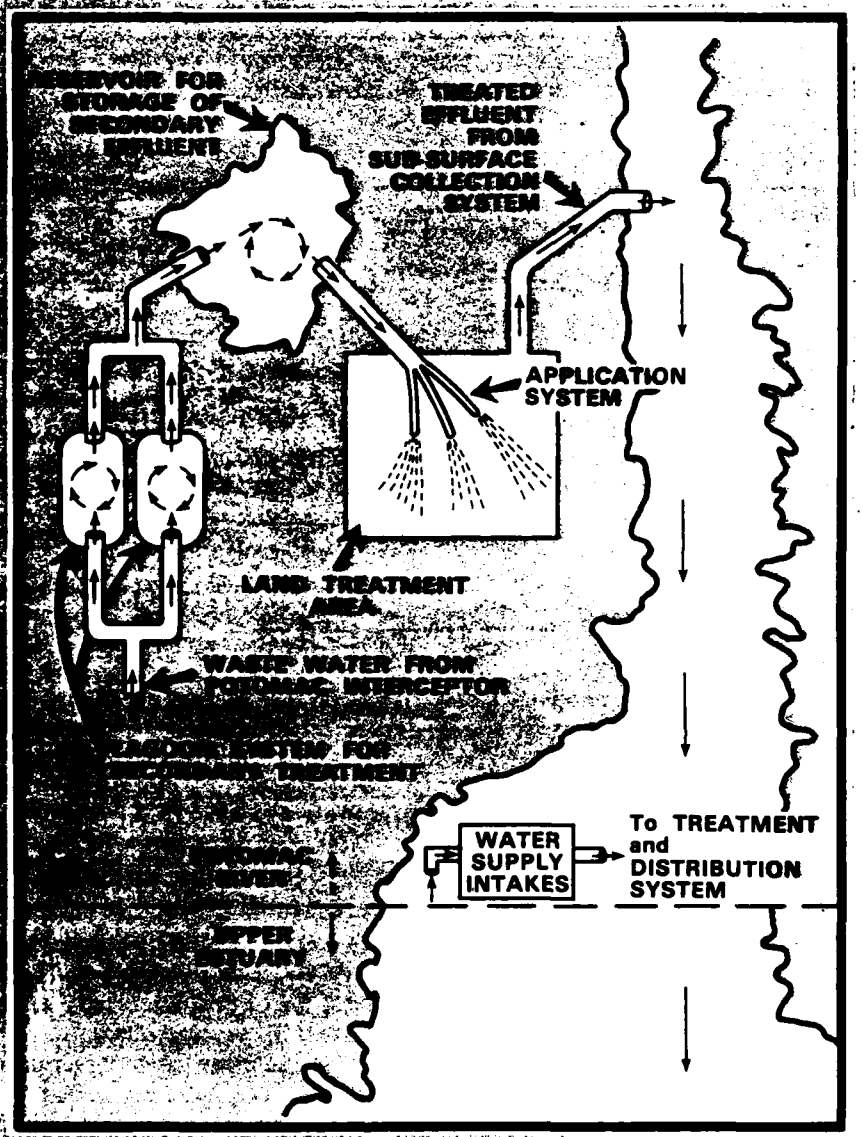


FIGURE A-14

Short-term deficits between 7 and 30 days duration would be alleviated with peaking projects to supply large quantities of water for short periods or through emergency water restrictions that would reduce the short-term peak demand. Application of restrictions were assumed to be a local responsibility and could reduce monthly demand to the level approximated by winter demands when lawn watering, filling of swimming pools, and similar non-essential activities are at a minimum.

In all programs, peak deficits of less than 7-days duration were assumed to be alleviated using demand reduction through emergency restrictions, local storage provided by water utilities, by reducing the assumed 100 mgd minimum flow into the estuary, or by using the emergency water supply intake. Volume of water supply was based on the monthly minimum safe yield of the Potomac River at Point of Rocks, less 100 mgd minimum flow to the estuary. Water supply systems in the MWA not utilizing the Potomac River as a source were assumed to operate at their existing capacity, contributing no additional supply to meet future demand.

SUPPLY, DEMAND, AND DEFICIT ANAYLSIS

The NEWS Study considered the Potomac River a good representation of available supply because it was the largest single source of available water in the MWA and was expected to be so in the future. The Potomac River reference gage chosen to best measure supply was the gaging station at Point of Rocks. This station was chosen because of its long period of record (since 1896) and its stability in supplying accurate measurements. Since the worst drought year on record at the Point of Rocks gaging station was 1930, the flows for that year were used by the NEWS Study as the region's dependable supply base.

The demands for the MWA were based on population projections by the Metropolitan Washington Council of Governments (MWCOG) and estimates of MWA per capita water use rates. The per capita water use rate for the MWA was considered by the NEWS Study to remain fairly stable throughout the study period because: (1) there was expected to be no appreciable increase attributable to water-using industries and (2) there exists a saturation of domestic water-using appliances in the MWA indicative of the relatively high income of the area.

The overall procedure used to match supply to demand was a critical part of the NEWS Study's response to the MWA's needs and desires. It was oriented toward the design of an efficient, flexible system that would rely more on the close monitoring of flows than on the principle of providing excess water as a safety factor.

A water deficit was defined as the difference between the available water supply and the estimated demand for water. The deficit calculation was of utmost importance in the formulation phase of the NEWS Study for it was this value that had to be met by the proposed alternative water supply programs. Figure A-15 shows the monthly deficits for the year 2020 using the 1930 monthly flows at the Point of Rocks gaging station. It can be seen from this figure that the critical months for water supply occurred from July through November with the month of August having the worst overall monthly deficit.

The NEWS Study calculated monthly, 7-day, and 1-day deficits for each of the five critical months (July through November). The monthly deficits were calculated by subtracting the monthly average supplies from the monthly average demands. In a similar manner, 7-day and 1-day deficits were calculated by subtracting 7-day and 1-day maximum demands from 7-day and 1-day minimum supplies, respectively.

NEWS PROJECTED REGIONAL SUPPLY DEMAND & DEFICITS FOR 2020

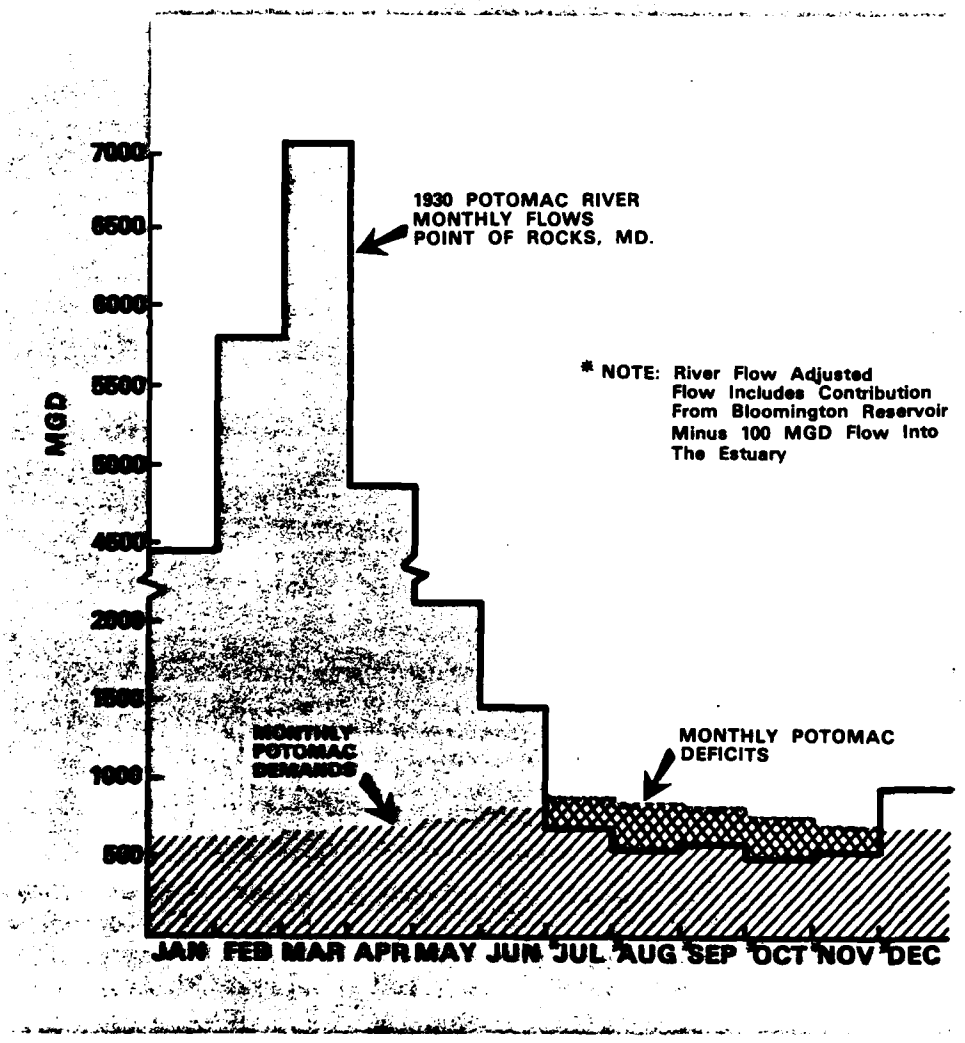


FIGURE A-15

FORMULATION OBJECTIVES OF THE NEWS STUDY

Water supply programs were formulated by combining the various alternatives, as previously defined, to meet future water supply deficits. In addition to future water supply deficits, the water supply programs were also guided by several formulation objectives. Table A-4 lists the program formulation objectives employed by the NEWS Study together with a definition of each.

TABLE A-4

PROGRAM FORMULATION OBJECTIVES

a. Low Risk: Programs formulated to achieve this objective should be able to meet both water quality and quantity needs on a safe and reliable basis.

b. Limited Environmental Impact: Programs formulated to achieve this objective should minimize adverse impacts on the environment, highlight positive features and conserve resources such as energy, natural resources, and natural habitat within the ecosystem.

c. Low Cost: Programs formulated to achieve this objective should have a low dollar cost per unit yield.

d. Growth Control: Programs formulated to achieve this objective should be consistent with land use and growth objectives. These objectives may favor high growth or low growth.

e. Flexibility: Programs formulated to achieve this objective should be flexible enough to adjust to changing needs or values of the MWA.

f. Social and Economic Equity: Programs formulated to achieve this objective should be equitable in terms of those who receive the benefits and those who pay the costs.

The potential water supply alternatives were evaluated under each of these six planning objectives. These alternatives represented water supply management techniques in different stages of technological development and testing for adequacy of yield, water quality, and adaptability into regional water supply programs. Alternative water supply programs were formulated to address various combinations of the six planning objectives and public interests. The forming of these five objective mixes was to reflect sets of compatible values expressed in feedback from residents of the MWA. Table A-5 shows these five objective mixes together with the selected objectives for each. After the initial program formulation and evaluation phase, it was found that the proposed projects could be separated into two groups: the technically feasible and immediately implementable projects (early-action alternatives) and a group consisting of feasible technologies requiring more detailed testing, analysis and impact evaluation (long-range alternatives).

TABLE A-5

THE NEWS STUDY OBJECTIVE MIXES

Mix 1: Low Risk, Limited Environmental Impact, Flexibility, and Social and Economic Equity.

Mix 2: Limited Environmental Impact and Growth Control.

Mix 3: Low Cost, Limited Environmental Impact, and Growth Control.

Mix 4: Low Risk, Low Cost, and Social and Economic Equity.

Mix 5: Low Risk, Low Cost, and Unlimited Growth.

The NEWS Study then selectively combined the seven most feasible water supply projects, in a staged fashion, into water supply programs to meet both the future water supply deficits and the five objective mixes. Through this process, a minimum of one program was developed for each of the five objective mixes. Figure A-16 shows the programs or branches (1 through 5) initially developed by the NEWS Study, together with their appropriate project make-up.

Upon completion of the first two stages of public involvement and plan formulation, the NEWS Study found that the goal of providing adequate water supply for the MWA could be approached from three distinct viewpoints represented by three separate objective mixes. One mix highlighted environmental needs and consisted of Limited Environmental Impact, Growth Control, and Low Cost. The second objective mix stressed reliability of water supply, operational flexibility, and cost. This mix was comprised of Low Cost, Low Risk, and Flexibility. The third objective mix, a compromise between the previous two, consisted of Low Risk, Low Cost, Limited Environmental Impact, Social and Economic Equity, and Growth Control. Consequently, the NEWS Study formulated three additional programs to address these mixes. These last three programs formed the early-action programs and were formulated with the idea of getting an early decision for the most needed projects. Branches 6, 7, and 8 of Figure A-16 show these programs.

CONCLUSIONS DERIVED FROM THE NEWS STUDY

The conclusions drawn by the NEWS Study were as follows:

1. Water supply deficits of one month duration or longer were unacceptable in the Metropolitan Washington Area.

2. Further studies were needed to:

a. Determine the yield available from groundwater.

b. Determine the feasibility of providing treated water from the Potomac Estuary.

c. Determine impacts of water use restrictions in the MWA.

NEWS ALTERNATIVE PROGRAM SCHEMATIC

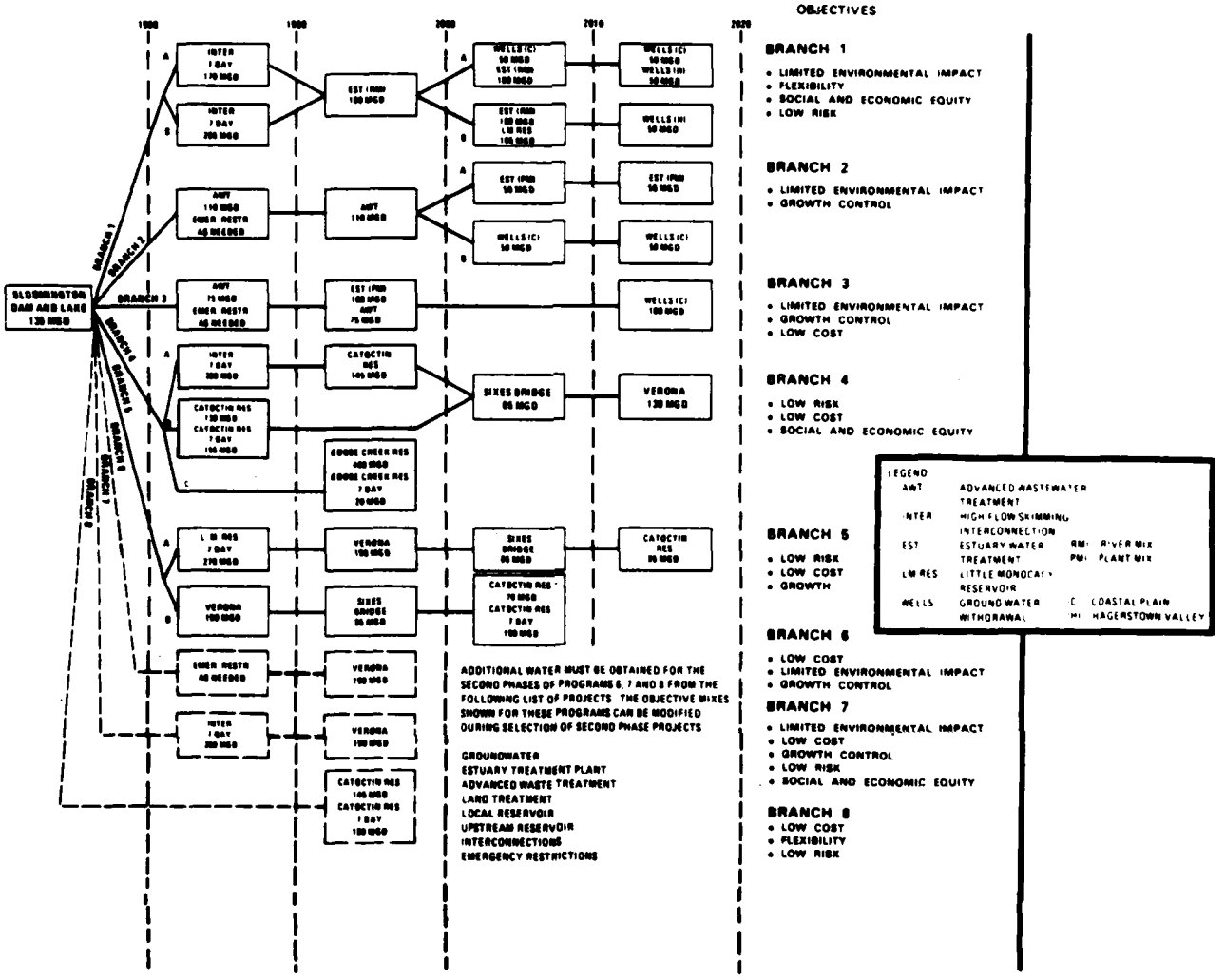


FIGURE A-16

d. Refine the methodology for predicting monthly, 7-day and daily flows and demands with consideration toward increasing the number of streamflow monitoring locations.

3. The efficient use of water is of prime importance in the MWA based on concerns expressed about the control of growth, conservation of resources, and demand reduction.

4. The MWA's water deficit problem is regional in the sense that many users rely on the Potomac River as a source. It would be almost impossible for local municipalities to implement feasible water supply solutions for the entire MWA as action taken by any user would affect the other users.

The conclusions and the technical analyses contained in the NEWS Study later played an important role in evaluating water supply alternatives for analysis in the MWA Water Supply Study.

NATURAL RESOURCE CHARACTERISTICS OF THE STUDY AREA

The following section provides an overview of the environmental setting and natural resources characteristics of the Potomac River Basin and the Patuxent River Basin in which the Metropolitan Washington Area is located. Concentration is primarily on the MWA Study area.

TOPOGRAPHY

POTOMAC RIVER BASIN

The Potomac River Basin as shown in Figure A-17 drains the eastern slopes of the Appalachian Highlands and the Coastal Plain in the Mid-Atlantic Region of the United States. The Potomac River and its tributaries drain approximately 14,670 square miles of land encompassing 5,720 square miles in Virginia, 3,820 square miles in Maryland, 3,490 square miles in West Virginia, 1,570 square miles in Pennsylvania, and 70 square miles in the District of Columbia. Of the total Potomac Basin, 3,090 square miles are drained by the Potomac River Tidal Estuary below the District of Columbia. The Basin is bounded by the Susquehanna River watershed to the north, the Ohio River watershed to the west, the James and Rappahannock watershed to the south, and the Patuxent River Basin and the Chesapeake Bay to the east.

The Potomac River flows 385 miles from the Allegheny Mountains to the Chesapeake Bay through five distinct physiographic provinces as illustrated in Figure A-18. Moving west to east, these provinces are: the Appalachian Plateau, the Ridge and Valley, the Blue Ridge, the Piedmont Plateau, and the Atlantic Coastal Plain. These provinces are aligned as parallel bands oriented in a northeast-southwest direction and have shaped the major land use characteristics and growth trends of communities within the Potomac Basin.

Situated in the extreme western portion of the Basin is the Appalachian Plateau Province. This Province covers an area roughly 15 miles wide and 50 miles long and accounts for approximately seven percent of the Basin's total area. The Plateau is deeply incised by streams and tributaries and has visual characteristics that are associated with the Allegheny Mountain Range.

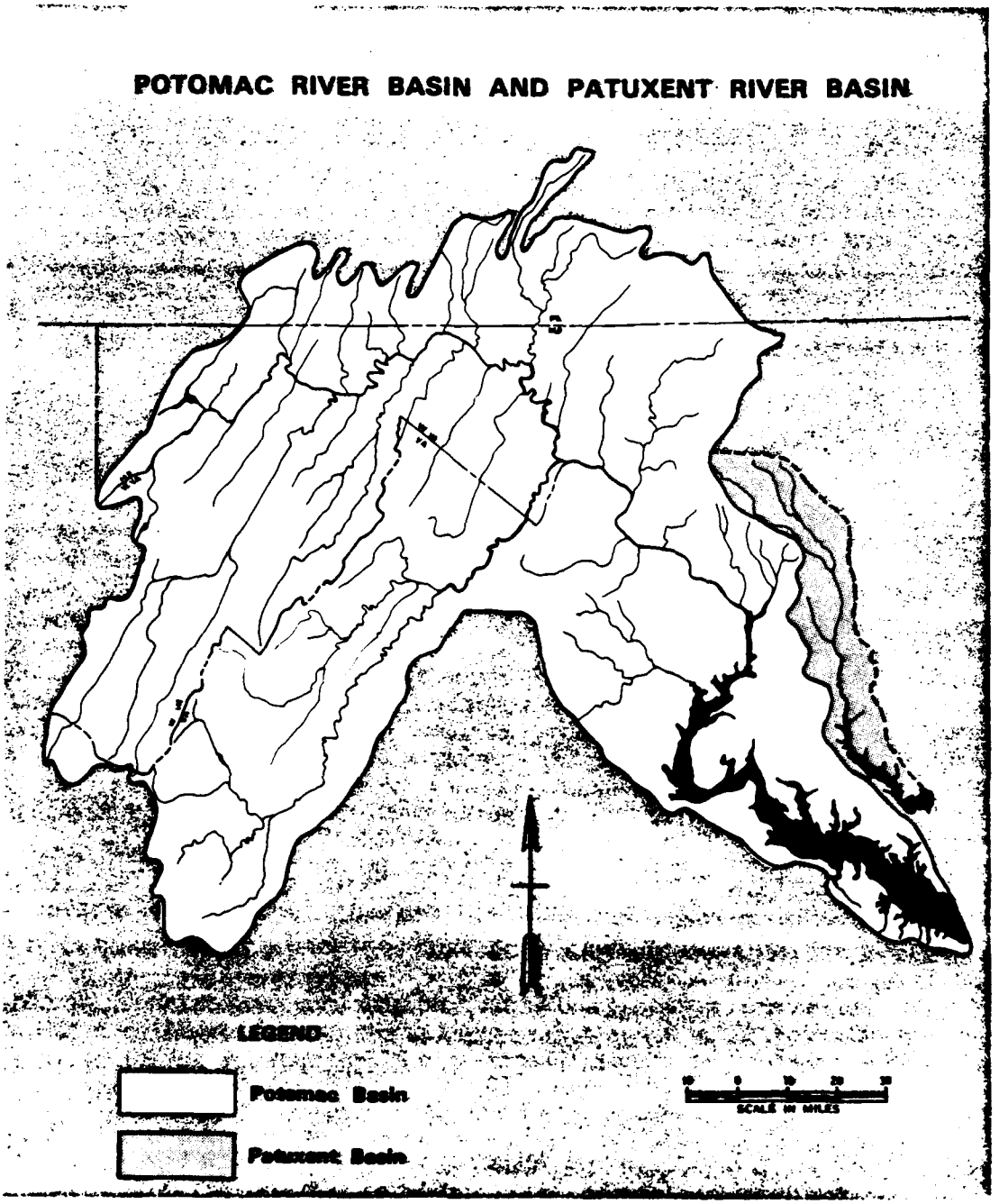

POTOMAC RIVER BASIN AND PATUXENT RIVER BASIN
LEGEND
Potomac Basin
Patuxent Basin
SCALE IN MILES

FIGURE A-17

PHYSIOGRAPHIC PROVINCES OF THE POTOMAC AND PATUXENT RIVER BASINS

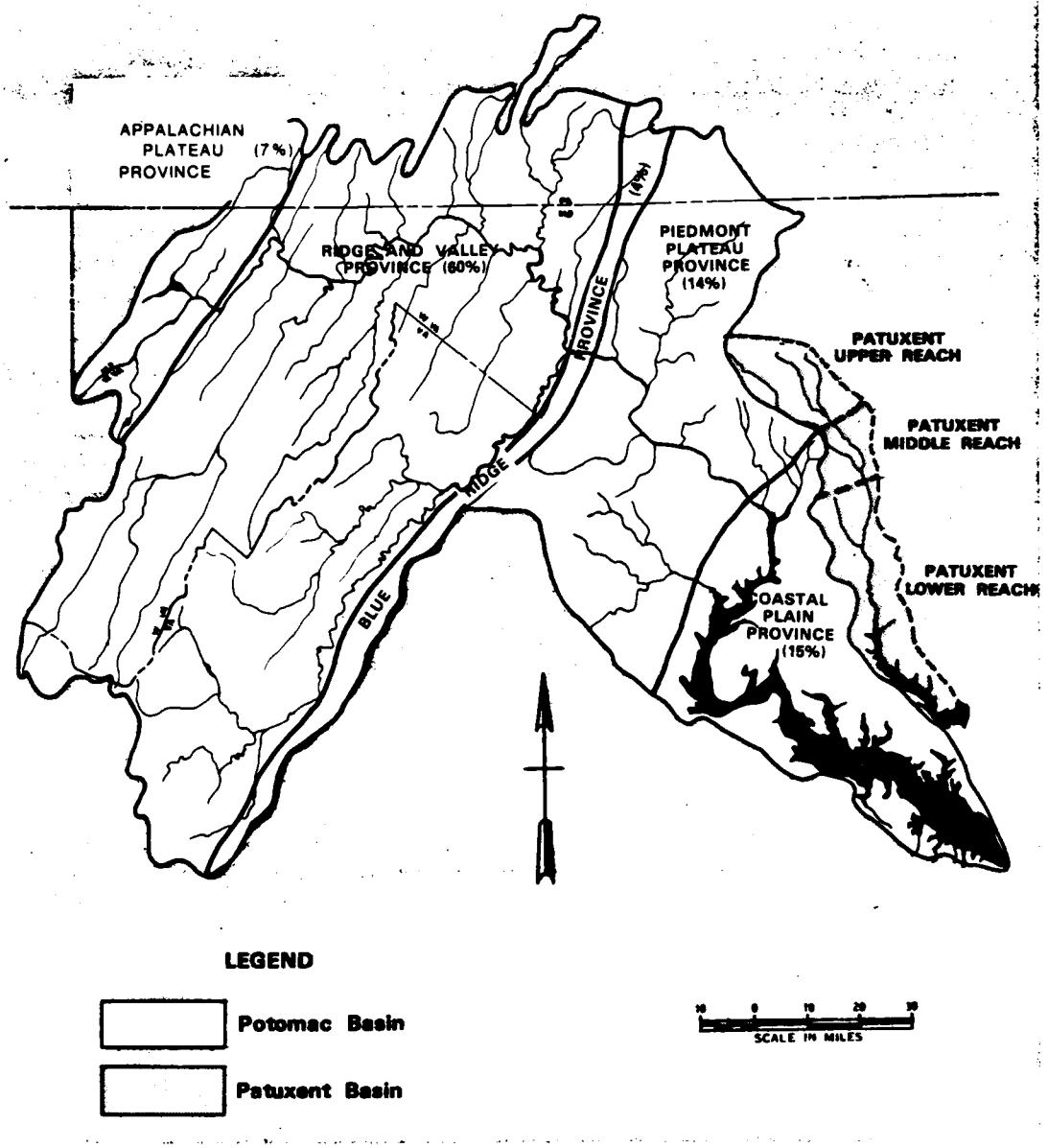


FIGURE A-18

East of the Appalachian Plateau Province is the Ridge and Valley Province which comprises roughly 60 percent of the entire Basin area. The area is appropriately named because it consists of a number of parallel valleys and ridges. The western portions are relatively steep and unpopulated and contain the greatest proportion of environmentally unaltered areas.

The Blue Ridge Province is a narrow mountainous belt roughly 4 to 20 miles wide, separating the Ridge and Valley Province from the Piedmont Plateau. This Province has a varying range of elevations exceeding more than 4,000 feet mean sea level at some locations. One of the outstanding features of this area is the scenic presence of the Blue Ridge Mountains.

The Piedmont Plateau Province, which makes up 14 percent of the total Basin surface area, is a mature, dissected, eastward sloping belt, characterized by rounded hills and V-shaped valleys. This Province, together with the Atlantic Coastal Plain Province, contains the highest degree of development within the Basin.

The Atlantic Coastal Plain Province is a gently undulating landscape, which is separated from the Piedmont Plateau Province by a natural break in slope, known as the Fall Line, a crude alignment of rapids and low falls which approximate the boundary between the crystalline rocks of the Piedmont and the softer sedimentary units of the Coastal Plain. The location of the Metropolitan Washington Area at the Fall Line gives it a dual advantage in terms of using the resources of both the freshwater portion of the Potomac River as well as the waters of the Potomac Estuary.

PATUXENT RIVER BASIN

Another major river system serving the remaining portion of the MWA is located in the Patuxent River Basin also shown in Figure A-18. The Patuxent River Basin contains a drainage area of approximately 930 square miles of which 280 square miles are located in the MWA. The River forms the eastern boundary of Prince Georges and Montgomery Counties, Maryland.

The Patuxent River Basin traverses two distinct physiographic regions - the Piedmont Plateau and the Coastal Plain. The upper portion of the Basin is composed of rolling uplands and lies in the Piedmont Plateau Province entirely within Howard and Montgomery Counties. It extends from the Frederick County line to the Fall Line at Laurel on the main stem and to the town of Savage on the Little Patuxent River Branch. The middle portion of the Basin, which extends from the Fall Line into the Coastal Plain, is located primarily in Anne Arundel and Prince Georges Counties. It is characterized by broad, flat, low-lying, swampy flood plains located on both sides of the River and its tributaries. The stream is relatively narrow and shallow, with the banks heavily forested and generally inaccessible. Moving downstream, the lower portion of the Patuxent River Basin, which lies in Charles, Calvert, and St. Mary's Counties, is characterized by the long, narrow, tidal estuary, an arm of the Chesapeake Bay.

METROPOLITAN WASHINGTON AREA

The Metropolitan Washington Area occupies an area of approximately 3,000 square miles of land and water within the Potomac and Patuxent Basins. The MWA is also situated in parts of the Blue Ridge, Piedmont Plateau, and Atlantic Coastal Plain Provinces.

Because of this physiography, the MWA surface elevation increases from near sea level to approximately 1,800 feet mean sea level, with the major portion of the region gently rolling and ranging between 200-600 feet in elevation.

GEOLOGY

The diverse geology of the region corresponds geographically with the five physiographic provinces. The Appalachian Plateau Province, which contains the westernmost portion of the Potomac Basin, is a high, deeply dissected plateau formed in gently warped rocks of Upper Devonian, Mississippian, and Pennsylvanian age. Nearly horizontally bedded shales, sandstones, coal, and shallow surface soils predominate this region.

The majority of the Potomac River Basin is included in the Ridge and Valley Province, which extends from the Allegheny to the Blue Ridge Mountains. This province is composed of intensely folded and, in many cases, faulted sedimentary rocks. The eastern portion of the Province is a broad limestone valley collectively called the Great Valley (Shenandoah Valley) in Virginia and Maryland and the Cumberland Valley in Pennsylvania. The western portion of the Province is primarily composed of narrow ridges and valleys with shales evident in the valleys and sandstones generally forming the ridges.

The Blue Ridge Province, as noted in Table A-6, is an area underlain with folded and deformed metamorphic and igneous rocks such as sharply folded quartzites, gneisses, phyllites, and greenstones. Occurring in the westernmost portion of the MWA, these rocks form a sharp northeast trending ridge in Loudoun County, rising over 1,000 feet above mean sea level.

Rocks within the Piedmont Plateau Province are relatively resistant metamorphic schists and gneisses of Precambrian age (600 million years or older). On the uplands, these rocks are deeply weathered. At depth, these rocks are massive and highly resistant, and can be found in the stream and river valleys, such as Rock Creek and the Potomac River, where they have been stripped of cover by erosion. An area of down-faulted Triassic sediments forms the western section of the Piedmont Plateau in the MWA.

The Coastal Plain consists of a series of unconsolidated sedimentary formations of gravels, sands, silts, and clays that thicken eastward from the Fall Line forming a wedge of materials. Four principle water-bearing strata occur in the area: the Patuxent, Patapsco, Magothy, and the Aquia Greensand Formations. All of these important water-bearing formations outcrop in the MWA and have important recharge areas in adjacent counties.

MINERAL RESOURCES

The distribution of mineral resources is a direct consequence of the geology of the region. Sand and gravel, derived from the Coastal Plain formations can be extracted from numerous pits along the eastern border of Montgomery County, Maryland; Fairfax

TABLE A-6

GEOLOGICAL FORMATIONS OF THE
METROPOLITAN WASHINGTON AREA

BLUE RIDGE PROVINCE

Biotite-Quartz-Feldspar Gneiss
Massive to Gneissic Granitic Rocks
Catoctin Formation - Basin Volcanic Rocks

PIEDMONT PLATEAU PROVINCE

Triassic Lowland Section
Newark Group - Arkosic Sandstone and Red Shale with Conglomerate
Basaltic Rock - Diabase and Gabbro in Sills and Dikes

Piedmont Plateau
Phyllites - Fine Grained Mica Schist and Chlorite Schist
Serpentinite, Steatite, and Related Gabbroic Rocks
Gneiss and Schist - Typically Massive and Granitic in Appearance
Amphibolite - Epidote Amphibolite - Metamorphosed Gabbro
Wissahicken Formation - Coarse Mica Schist and Mica Gneiss
Massive to Gneissic Granitic Rocks

COASTAL PLAIN PROVINCE

Patuxent Formation - Interbedded Gravel, Sand, and Clay
Arundel and Patapsco Formation - Massive Clay, Variegated and Sandy
Monmouth Formation - Glauconitic Silty Quartz Sand, Fine Black
Magothy Formation Included at Base
Nanjemoy and Wicomico Formations - Glauconitic Sand Interbedded
with Dark Silt
Aquia Formation - Glauconitic Coarse Sand
Chesapeake Group - Silty Quartz Sand Locally Clayey
Brandywine Gravel
Alluvium - Gravel, Sand, Clay
Quantico Slate

SOURCE: Metropolitan Washington Council of Governments, Natural Features of the Washington Metropolitan Area (1968).

and Prince William Counties, Virginia; and Prince Georges and Charles Counties, Maryland. Abundant clay resources extracted from shale and clay formations in the Coastal Plain section of the MWA have made brick a major local building material. Parts of the Piedmont Plateau and Blue Ridge Province are underlain with significant quantities of material suitable for crushed and building stone. Table A-7 lists the type and distribution of existing and potential mineral resources in the MWA.

It is expected that in the future, the demand for construction materials, particularly sand and gravel, will increase with the increase of population and development. Pressures on area mineral resources, caused by extractive operations and also by the spread of urban development, have preempted potential extractive sites. Continuation of such losses will eventually cause the demand to be met by sources in adjacent areas, with a resultant increase in costs primarily due to increased transportation charges.

SOILS

The soils of the MWA can be generally grouped into seven broad categories that correspond to the geological formations. The seven categories include:

- Soils on crystalline rocks of the Piedmont and Blue Ridge
- Soils on sandstone, shale, and conglomerate of the Triassic Lowland
- Soils on limestone of the Triassic Lowland
- Soils on mixed crystalline rocks and Coastal Plain Sediments
- Soils on Coastal Plain Sediments
- Soils on alluvial terraces
- Soils on flood plains

The soils on the crystalline rocks of the Piedmont and the Blue Ridge cover approximately half of the MWA. These soils are shallow to deep loam, or silt loam on rolling to steep topography. Although most soils in this area are well drained with no water table problems, several are susceptible to severe erosion.

The soils on sandstone, shale, and conglomerate of the Triassic Lowland occur in western Montgomery County, Maryland, and parts of Fairfax and Loudoun Counties, Virginia. These soils are shallow to moderately deep silt loams to sandy loams on gently rolling topography with many areas that are nearly level and poorly drained. An exception is the Bucks soil, a deep and well drained, gently sloping soil group that occurs in large areas in this association.

The soils on limestones of the Triassic Lowland cover about 12 square miles in Loudoun County. Derived from limestone conglomerate, these soils generally are moderately well to excessively drained, and range in texture from gravelly to rocky to silt loam. If sufficiently deep, these soils are well suited to agriculture.

TABLE A-7

MINERAL RESOURCES IN THE MWA

MINERAL RESOURCE	USE	DISTRIBUTION
Sand and Gravel	Construction material, fill, base course for highways.	Charles, Prince Georges, Montgomery Counties, Maryland; District of Columbia; Prince William, Fairfax Counties, Virginia.
Shale and Clay	Brick and tile	Prince Georges County, Maryland; Fairfax, Prince William Counties, Virginia.
Serpentinite	Crushed stone for concrete aggregate, binder filler, road metal, base course for highway.	Montgomery County, Maryland; Fairfax County, Virginia.
Diabase	Crushed stone for road metal, railroad fill, potentially suitable as base course aggregate, binder filler.	Montgomery County, Maryland; Fairfax, Loudoun, Prince William Counties, Virginia; District of Columbia.
Gneiss, Granite Quartz, Diorite	Building stone for bridges, dams, veneer, riprap, slate.	Montgomery County, Maryland; District of Columbia; Fairfax, Prince William, Loudoun Counties, Virginia.
Schist	Building stone for flagstone, veneer, riprap, slate.	Montgomery County, Maryland; District of Columbia; Fairfax, Prince William, Loudoun Counties, Virginia.
Sandstone	Building stone.	Western Montgomery County, Maryland; Fairfax, Prince William, Eastern Loudoun Counties, Virginia.
Quartzite	Building stone, possible use in glass industry.	Western Montgomery County, Maryland.
Slate	Roofing and flagstone.	Montgomery County, Maryland, interbedded with quartzite; small-pockets in east-central Fairfax, Prince William Counties, Virginia.

SOURCE: Metropolitan Washington Council of Governments, Natural Features of the Washington Metropolitan Area (1968), USGS, Map-Miscellaneous Investigations Series I-920-E, 1975.

The soils on mixed crystalline rocks and coastal plain sediments cover a 42 square mile strip that extends from central Fairfax County, Virginia, into Arlington County, Virginia. These soils, exhibiting characteristics of both the Piedmont and Coastal Plain Soils, are silt loams and loams that range from poorly drained to well drained and are nearly level to steep.

The soils of the Coastal Plain sediments occur east of the Fall Line in Charles and Prince Georges Counties, Maryland; and eastern Fairfax and Prince William Counties, Virginia. The soils vary from sandy to clayey and from poorly to excessively drained. Common problems of the area include high water table, severe erosion, and earth slides.

The soils on alluvial terraces and floodplains are a result of previous and existing floodplains, respectively. The soils on the alluvial terraces are good sources of gravel. Both alluvial terrace soils and floodplain soils are favorable for agriculture.

REGIONAL SEISMICITY

The MWA is situated in a region which has historically experienced a minor amount of seismic activity. Although 17 earthquakes have been reported in a 100 mile radius centering around Washington, D.C., since the mid-sixteenth century, none have been of major or of catastrophic proportion. The measure of local destructiveness determined for all of these earthquakes, according to the Modified Mercali Scale of Earthquake Intensity, was V(5) and was thus below the level of intensity to cause significant damage to structures.

CLIMATE

POTOMAC RIVER BASIN

The Potomac River Basin has a generally temperate climate, with extremes more pronounced in areas west of the Blue Ridge Mountains. Winters in the Basin are moderately cold, with January temperatures averaging 33 degrees Farenheit (F) in the mountains and 37 degrees F in the lowlands (tidewater areas). The summers are warm and humid in the lowlands, with July temperatures averaging around 77 degrees F, while in the mountains the average July temperature is somewhat cooler at 72 degrees F. In general, the mean annual temperature for the Potomac Basin ranges from 59 degrees F in the lowlands to 51 degrees F in the mountains. The average frost-free season ranges from 150 days in the mountains to 200 or more days in the lowlands.

Precipitation throughout the year is abundant and seasonally well distributed, but not unusually excessive. The mean annual precipitation ranges between 30 to 35 inches at the foothills of the Allegheny Mountains, increases to 45 inches along the crest of the Blue Ridge Mountains, and averages 50 inches or more on the western divide. In the Coastal Plain region, the average annual precipitation ranges between 40 to 42 inches. Figure A-19 is an isohyetal map showing equal mean precipitation in the Potomac River Basin.

PATUXENT RIVER BASIN

The climate of the Patuxent River Basin is considered generally temperate with no major extremes. The mean annual temperature is about 58 degrees F with monthly extremes of

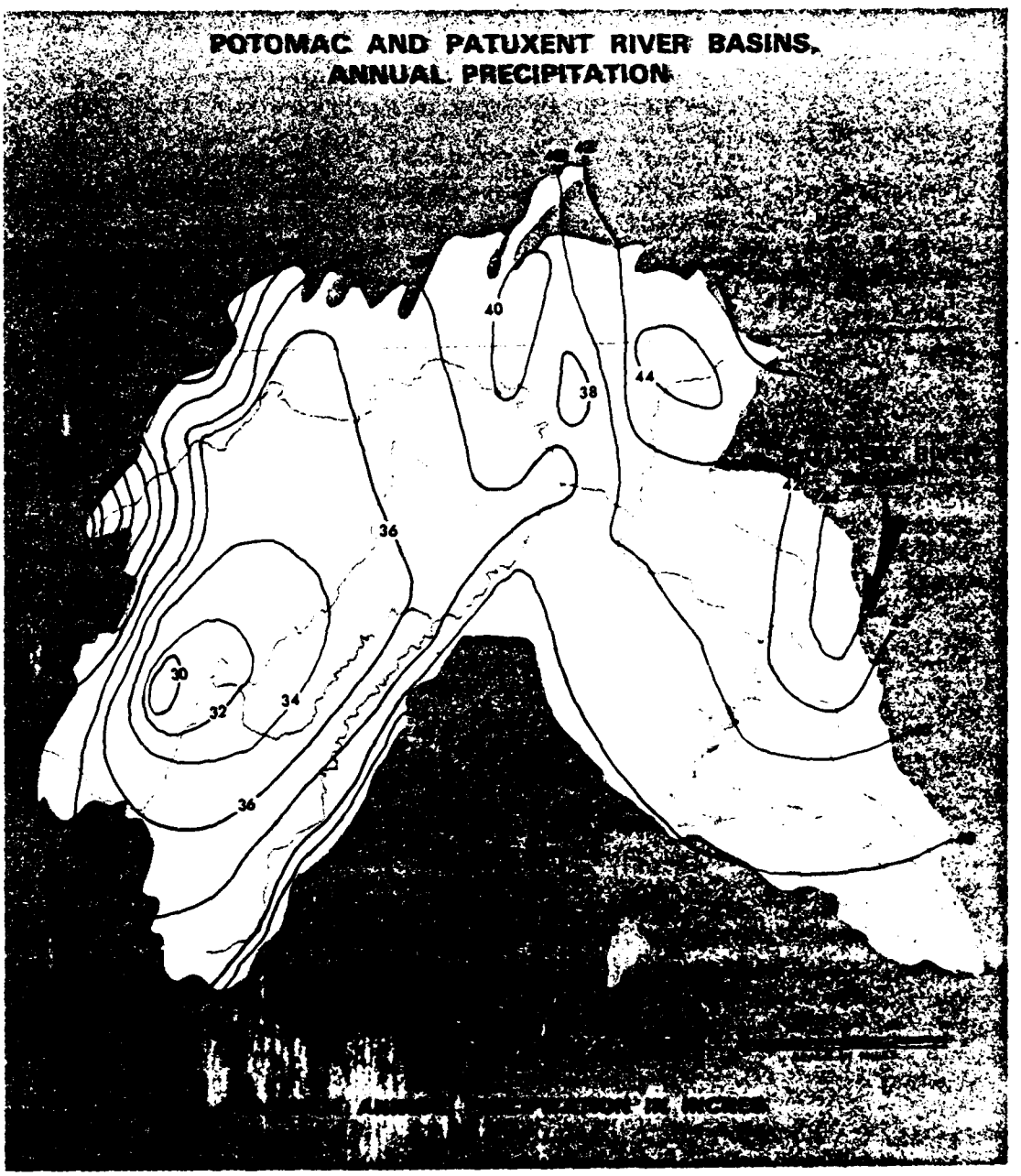

POTOMAC AND PATUXENT RIVER BASINS.
ANNUAL PRECIPITATION
40
38
44
36
30
32
34
36

FIGURE A-19

35 degrees F in January and 77 degrees F in July. The area is characterized by plentiful sunshine, abundant precipitation mainly in the form of rainfall, and a relatively long frost-free season. The mean annual precipitation in the Patuxent Basin is about 40 to 44 inches with monthly amounts ranging from 2.5 to 3.0 inches in February to 5.5 to 6.0 inches in July and August.

METROPOLITAN WASHINGTON AREA

As part of the Potomac and Patuxent River Basins, the Metropolitan Washington Area is influenced by the climatic conditions generated within the two Basins. The climate of the MWA is temperate with seasonal extremes more pronounced in the northern and western suburbs than in the eastern tidewater areas of Charles County, Maryland, and Prince William County, Virginia. The summers are warm and humid, with the month of July exhibiting the highest mean temperature of 78.4 degrees F. The winters in the MWA are generally mild, with the month of January having the lowest mean temperature of 36.1 degrees F. Table A-8 summarizes the monthly temperatures for the MWA by average maximum, average minimum, and mean values as recorded at the Washington National Airport for the period of record 1936-1977.

Precipitation within the MWA is not defined by wet and dry seasons. In general, there is a greater abundance of precipitation during the period March through August than during the fall and winter. The average annual rainfall in the area is 40 inches and is distributed somewhat unevenly over the year, with the mean monthly precipitation ranging from 2.59 inches in January to 4.75 inches in August. Table A-9 summarizes the average maximum, average minimum, and mean monthly values for precipitation as recorded at the Washington National Airport for the period of record 1936-1977.

WATER QUALITY

As the Potomac River flows downstream, tributary streams contribute large quantities of water. The quality of the water of each tributary is influenced by variances in topography and discharges of wastewater effluent generated by domestic, industrial, and agricultural activities. For these reasons, the water quality of the Potomac River changes from one reach of the river to another in relation to the proximity of point and non-point pollutant discharges.

In the waterways of the North Branch Potomac River, the upper one-third is affected by acid mine drainage, originating from both active and abandoned coal mine operations. The middle and lower subreaches of the North Branch receive significant industrial and municipal discharges.

Water of better quality from large tributaries, including the South Branch Potomac River and the Cacapon River, helps to improve the relatively poor quality of the Potomac as it flows downstream. Dilution and self-purification make the water quality acceptable for the level and type of uses presently made of the river between Oldtown and Williamsport, Maryland. The population along this reach is relatively sparse. Surface runoff and wastewater from several small communities constitute the only known waste sources.

TABLE A-8

AVERAGE MONTHLY TEMPERATURE (°F)
MAXIMUM, MINIMUM, AND MEAN*

MONTH	MAXIMUM	MINIMUM	MEAN VALUE
January	43.5	28.1	35.8
February	46.5	46.5	38.0
March	55.2	36.8	46.0
April	66.7	45.8	56.3
May	75.8	55.9	65.9
June	83.7	65.0	74.4
July	87.5	69.5	78.5
August	85.8	68.1	77.0
September	79.3	61.4	70.4
October	69.0	50.0	59.5
November	57.1	39.7	48.4
December	45.8	30.7	38.3
AVERAGE ANNUAL	66.3	48.4	57.4

TABLE A-9

AVERAGE MONTHLY PRECIPITATION (Inches)
MAXIMUM, MINIMUM, AND MEAN*

MONTH	MAXIMUM	MINIMUM	MEAN VALUE
January	7.83	0.31	2.59
February	5.71	0.66	2.52
March	7.43	0.64	3.31
April	6.85	0.26	2.83
May	10.69	0.41	3.84
June	11.53	0.86	3.47
July	11.06	0.93	4.11
August	14.31	0.55	4.68
September	12.36	0.20	3.37
October	8.18	0.66	2.97
November	6.70	0.37	2.95
December	6.54	0.22	3.21
TOTAL AVERAGE ANNUAL			39.85

*1936-1977, Washington National Airport

SOURCE: U.S. Department of Commerce, NOAA 1977 Local Climatological Data, Annual Summary Comparative Data, Washington, D.C.

As the Potomac River flows toward the District of Columbia, residential, commercial, and industrial development becomes more intense along most tributary streams causing a deterioration in water quality. Principal sources of bacteria appear to be surface drainage. With the exception of the presence of bad taste and odor, the water is generally acceptable for most uses following proper treatment.

The water quality in the 40-mile reach of the upper Potomac Estuary is degraded by pollution from wastewater discharges. These discharges originate from the MWA's population of over three million, located near the Potomac Estuary. Further complications arise from the salinity level, which favors the flocculation, sedimentation, and retention of the sediment in the Estuary. In the lower Potomac Estuary, the water quality conditions are slightly improved. However, algal blooms, depleted oxygen at depth, and high coliform counts have been noted on some occasions.

The Occoquan Creek, which feeds into the Potomac Estuary is generally of poor quality. The basin, which includes Bull Run, Cedar Run, and Broad Run suffers non-point source pollution from urban and agricultural runoff. The basin also suffers from discharges from wastewater treatment plants; however in recent years the consolidation of several plants into one advanced wastewater treatment plant has improved the situation.

The water in the upper reach of the Patuxent River is clean and of good quality. The river receives no man-made pollution in this area. The water is of suitable quality to be used as a water supply by the Washington Suburban Sanitary Commission. Two reservoirs, Triadelphia and Rocky Gorge, are located on this section of the Patuxent River.

The middle reach of the river encompasses an area that has experienced rapid residential, industrial, and commercial growth. Wastewater discharge from a population of approximately 150,000 and associated industrial wastes are discharged into this reach of the river. The high pollution load and the sluggishness of the river water cause some pollution problems.

About 15 miles of the upper Patuxent Estuary is filled with silt. The salinity fluctuates greatly with freshwater flow, tides, and winds. The Estuary portion acts like a reservoir, retaining many of the pollutants that have been brought down the Patuxent.

TERRESTRIAL RESOURCES

VEGETATION

The Potomac and the Patuxent River Basins are noted for the quality and quantity of parks and woodlands. These areas comprise part of the temperate deciduous forest biome known as the oak-deer-maple biome, whose chief characteristic is the predominance of trees with broad leaves that shed each autumn. The understory of small trees is also deciduous. Slight variation in this classification system exists with changes in physiography.

The dominance of the oak-hickory-chestnut forest throughout most of the area has been diminished through lumbering, agriculture, and the death of the American chestnut from the chestnut blight. The largest areas of oak-chestnut-hickory forest were on the lower

ridges of the Blue Ridge Mountains and on the Piedmont. Since the blight of the American chestnut, the forests are becoming more populated with red oak, chestnut oak, and white oak. The Southern Piedmont and Coastal Plain are still dominated by loblolly and shortleaf pine forests. The extreme western Potomac Basin in the more mountainous reaches shows the dominance of elms and basswood.

There are about 50 deciduous shrubs and understory trees that are important in the forest, along with about 15 evergreen shrubs and a dozen vines. These subordinate species support a rich fauna of insects and spiders. The understory trees include American hornbeam, hophornbeam, sassafras, eastern redbud, flowering dogwood, and striped maple. Important shrubs are pawpaw, spicebush, arrow wood, black huckleberry, blueberry, witchhazel, and Virginia creeper.

For the most part in the MWA the original hardwood forest has been replaced by urban, suburban, and agricultural habitats. Vegetative communities range from short grass lawns and planted trees in urban areas, to semi-forested/residential areas in suburban areas, to old field or cultural fields in agricultural areas.

Most of the rivers and streams in the MWA still support typical bottomland or floodplain forests. Typical forest communities included sycamore, beech, elm, box elder, pin oak, beech, and maple.

WILDLIFE

Important animals originally associated with the oak-chestnut-hickory forest were deer, elk, wolves, mountain lion, black bear, bobcat, gray fox, raccoon, fox squirrel, eastern chipmonk, white-footed mouse, pine vole, and short-tailed shrew. Since colonial days, the timber wolf, panther, elk, and American bison have entirely disappeared; however, the black bear and the bobcat are still found in the heavily timbered reaches of the Potomac River Basin in the Allegheny Mountains.

A much greater number of nongame forest and river species exists in the Potomac and Patuxent River Basin environments. Most of the small birds do not stay in the forest throughout the year. The tufted titmouse is one of the few species ranging through nearly all the subdivisions of the biome and is present throughout the year. The blue jay extends its range northward into the boreal coniferous forest. Other important year-round resident species are the redbelly, hairy, and downy woodpecker; the white-breasted nuthatch; two species of owls; and two species of hawks. The eastern wood pewee, wood thrush, and the Acadian flycatcher carry on their warm season activities within the deciduous forests of the Potomac and Patuxent Basins. Other common summer resident species are the yellow-billed cuckoo, great crested flycatcher, red-eyed vireo, yellow-throated vireo, cerulean warbler, overbird, and scarlet tanager.

The box turtle, common garter snake, timber rattlesnake, and northern black racer all are characteristic reptiles of the forest. Lizards do not occur in the climate of northern areas, but may be found in sandy habitats. Amphibians are only represented by the slimy salamander through most of the deciduous forest.

AQUATIC RESOURCES

VEGETATION

A review of the literature indicates that information on the aquatic vegetative resources of the non-tidal sections of the Potomac River is limited. Existing data, however, suggest that high planktonic production has occurred in the river.

In the estuarine section of the river, fairly extensive data exist with regard to phytoplankton. As in most estuarine situations, conditions in the upper Potomac Estuary are conducive to the production of phytoplankton. Benthic algal primary production is generally reduced because of high turbidity. These groups appear to be relatively unimportant in comparison to phytoplankton in this portion of the estuary, however, there have been no quantitative evaluations. Small marshes begin to occur in the vicinity of the Woodrow Wilson Bridge and are more numerous along tributary streams than on the main stem. Their significance increases in a downstream direction, with the bulk of the Potomac River marshes occurring below the MWA.

Almost all of the work in the primary productivity in this region of the estuary has been directed toward evaluation of the causes of noxious phytoplankton blooms which have occurred in the area since the late 1950's. Prior to 1920, there is no evidence of nuisance growths of aquatic plants. By the early 1930's the upper estuary, especially the tributary streams, suffered from an infestation of water chestnut (Trapa natans). This was eradicated by an intensive harvesting program. In the 1940's and early 1950's extensive growths of Eurasion water milfoi' (Myriophyllum spicatum) were common. These milfoil blooms disappeared naturally in the late 1950's, and since then the major problem has been massive, persistent, blue-green algal blooms. Algal blooms are a typical symptom of eutrophic conditions. Aside from their undesirable aesthetic aspects, they can also cause large diurnal fluctuations in the dissolved oxygen content of the water and disrupt the food chain. Nutrient enrichment from agricultural and urban runoff basin-wide, and from wastewater treatment facilities in the upper estuary, is considered to be the major factor causing the blooms. From 1972 through 1975 no major blooms occurred, although the nutrient levels appear to have been high enough to support blooms.

FISHERIES

Many natural and modified stream habitats exist, governed by various physical factors such as width, depth, temperature variations, water quality, bottom type, flow, shade cover, and erosion. Cold water streams in the basin support limited populations of native brook trout that are supplemented by annual stocking of hatchery-reared trout. A large proportion of the 1,500 acres of available natural cold water streams in the North Branch of the Potomac River are automatically eliminated because of acid mine drainage. Smallmouth bass streams account for about 15,000 acres of the fishery resource, combining high natural productivity and aesthetic appeal. The South Fork of the Shenandoah River, the South Branch of the Potomac River, and the Cacapon River are among the finest bass streams in the United States. Catfish streams account for about 14,000 acres of the available 33,000 acres of fishery habitat above Great Falls. The slower moving, warmer and more polluted catfish streams support moderate game fish populations and afford high density recreational land use in proximity to larger urban areas. The results of recent surveys suggest that the stretch of river between

Washington, D.C. and the Monocacy River supports a relatively diverse fish population, and there are no indications of any recent declines in the number of species present. Some of the species observed in the river are indicated in Table A-10.

The Potomac River Estuary supports a significant fishery, both in terms of anadromous and resident species. Sixty-four species of fish have been collected from the estuary below Washington; however, many of these are estuarine or marine and do not enter the upper estuary. A partial listing of these species is presented in Table A-11.

Fish within the estuary may be either fresh water spawners, estuarine spawners, or marine spawners. All use the estuary as a nursery ground. Fresh water spawners include the totally fresh water species in the area, as well as many anadromous varieties. Forty-three of 116 rivers and streams draining in the Potomac Estuary currently support spawning for one or more anadromous species. The most widespread spawners are the white perch and the three species of herring, found in 30 separate streams. Significant spawning of yellow perch, alewife, blueback herring, American shad, white perch and/or striped bass occurs from the Wicomico River up to Little Falls.

Estuarine species spawn and mature in higher salinity waters below the study area. In general, the larvae of this group either remain in the area of where they are hatched, or move upstream to the vicinity of the salt-fresh water interface. Significant species include the bay anchovy, salt marsh killifish, silversides, and tidewater silversides.

Marine spawners are fish whose larvae hatch in the marine environment and show varying degrees of dependency on the upper estuary. Of these, only the American eel and spot are known to move into the fresh water portion of the estuary. The most important species utilizing the upper estuary at some stage in their life history are the American shad, alewife, blueback herring, channel catfish, brown bullhead, white catfish, white perch, striped bass, American eel, yellow perch, and the hogchoker.

The striped bass is likely the most important species dependent on the upper estuary. The adults are found in coastal ocean areas along the entire east coast; and the Chesapeake Bay, including the Potomac River, is one of the principal spawning and nursery areas for the population. As early as April, adults begin moving up the estuary and continue until June when spawning occurs in tidal fresh or slightly brackish waters. Spawning appears to be concentrated in the main stem from Sandy Point to Hallowing Point. The presence of striped bass eggs and larvae has been reported from the vicinity of Piscataway Creek to Morgantown, Maryland. After the eggs hatch, the larvae move out of fresh water into low salinity areas. In all, 2 or 3 years elapse before the juveniles leave the Chesapeake Bay system.

The American eel is a catadromous species, that is, the adults move into the ocean to breed, and the young return to fresh water to mature. Eels enter the estuary as elvers (small eels) in the spring after a yearlong migration from the spawning grounds somewhere in the Sargasso Sea. They migrate great distances into fresh water and are found in the Potomac system at least as far upstream as the confluence with the Monocacy River. They are extremely hardy and can tolerate almost any conditions likely to be encountered in the river as it presently exists.

TABLE A-10

FISH REPORTED IN THE POTOMAC RIVER AND TRIBUTARIES
FROM WASHINGTON, D.C., TO THE MONOCACY RIVER

Sea Lamprey	Carp	Banded killifish
American eel	Comely shiner	Rock bass
Brook trout	Roseyface dace	Redbreast sunfish
Gizzard shad	Swallowtail shiner	Green sunfish
Alewife	Satinfin shiner	Warmouth
American shad	Spottail shiner	Pumpkinseed sunfish
Bowfin	Spotfin shiner	Bluegill sunfish
Atlantic sturgeon	White sucker	Longear sunfish
Blacknose dace	Hogsucker	Smallmouth bass
Longnose dace	Redhorse sucker	Largemouth bass
Rosyside dace	Creek chubsucker	White crappie
Creek chub	White catfish	Black crappie
Fallfish	Yellow bullhead	Tessellated darter
Cutlips minnow	Brown bullhead	Shield darter
Golden shiner	Channel catfish	Fantail darter
Silverjaw minnow	Blue catfish	Greenside darter
Bluntnose minnow	Margined madtom	Walleye
River chub	Trout-perch	Yellow perch
Stoneroller	Mottled sculpin	Goldfish
Fathead minnow	White perch	Mosquitofish
Silvery minnow	Striped bass	

SOURCE: Final Environmental Impact Statement Concerning Proposed Potomac River Water Supply Structures; Prepared by the U.S. Army Corps of Engineers, Baltimore District, June 1978.

TABLE A-11

FISH SPECIES COLLECTED AT FENWICK AND INDIAN HEAD, MARYLAND
1956-1974

SPECIES	SITES	
	Fenwick	Indian Head
Alewife, Alosa pseudoharengus	X	X
American eel, Anguilla rostrata	X	X
American shad, Alosa sapidissima	X	X
Atlantic menhaden, Brevoortia tyrannus	X	X
Atlantic needlefish, Strongylura marina	X	X
Atlantic silverside, Menidia diaphanus	X	X
Banded killifish, Fundulus diaphanus	X	
Bay anchovy, Anchoa mitchilli	X	X
Blueback herring, Alosa aestivalis	X	X
Bluegill, Lepomis macrochirus		X
Brown bullhead, Ictalurus nebulosus	X	X
Carp, Cyprinus carpio	X	X
Channel catfish, Ictalurus punctatus	X	X
Chain pickerel, Esox niger	X	X
Gizzard shad, Dorosoma cepedianum	X	X
Golden shiner, Notemigonus crusoleucas	X	X
Hickory shad, Alosa mediocris		
Hogchoker, Trinectes maculatus	X	
Mummichog, Funiulus heteroclitus	X	
Northern hog sucker, Hypentelium nigricans		X
Pumpkinseed, Lepomis gibbosus	X	X
Quillback, Carpiodes cyprinus	X	
Redear sunfish, Lepomis microlophus		X
Rough silverside, Membras martinica		X
Satinfish shiner, Notropis analostanus	X	X
Silvery minnow, Hybognathus nuchalis	X	X
Smallmouth bass, Micropterus dolomieui		X
Spot, Leiostomus xanthurus	X	X
Spottail shiner, Notropis hudsonius	X	X
Striped anchovy, Anchoa hepsetus	X	X
Striped bass, Morone saxatilis	X	X
Striped killifish, Fundulus majalis	X	
Tessellated darter, Etheostoma olmstedi	X	X
Threadfin shad, Dorosoma petenense	X	X
Tidewater silverside Menidia beryllina	X	X
White catfish, Ictalurus catus	X	X
White perch, Morone americana	X	X
Yellow perch, Percha flavescens	X	X

SOURCE: Final Environmental Impact Statement Concerning Proposed Potomac River Water Supply Structures; Prepared by the U.S. Army Corps of Engineers, Baltimore District, June 1978.

The Patuxent River (main stem), the Little Patuxent, and their respective tributaries, draw considerable sport fishing use from the Washington and Virginia population centers. Rocky Gorge and Triadelphia, two water supply reservoirs located on the Patuxent River, each provide 800 acres of pond-type habitat that support a wide variety of recreationally and non-recreationally important fish species which are listed in Table A-12. A stocking program for the two reservoirs exists for game species, notably, bass, northern pike, and catfish. Resident populations have been established but are relatively small. The Patuxent and Little Patuxent Rivers also provide considerable riffle type habitat for nest building species.

The Occoquan and related tributaries support a wide variety of game and non-game fish species. Habitat types vary from a bond (reservoir) effect in the Occoquan Bay to a fast flowing headwater habitat farther upstream (Bull Run and Little Bull Run). Recreational use of these areas is quite high, particularly in the Occoquan Reservoir impoundment. Channel cats, striped bass, and northern pike are currently stocked in sizable numbers.

RARE AND ENDANGERED SPECIES

Within the study area, only two species are protected by law (Endangered Species Act of 1973; 16 U.S.C. 1531-1543): the Southern bald eagle (Haliaeetus leucocephalus leucocephalus) and the peregrine falcon (Falco peregrinus tundrius). The Chesapeake Bay region is the most productive area for bald eagles north of Florida, and they are dependent upon fish food sources from the Potomac River and the lower estuarine waters. Charles County, Maryland, has a breeding population of four or five pairs of eagles. Additionally, eagles frequent the shores of the Patuxent River during the period of January through July. The peregrine falcon is an occasional winter or migratory visitor.

The endangered rainbow snake and eastern tiger salamander have both been found in Charles County. There are no rare invertebrates listed for Montgomery, Prince Georges, or Charles Counties, Maryland.

One rare plant, the purple fringeless orchis Platanthera (Habenaria) peramoena, is on the Smithsonian's state list of endangered and threatened plant species. This plant, which has been collected in Montgomery County, is found in meadows, bogs, alluvial thickets, and low woods.

PROFILE OF SOCIO-ECONOMIC RESOURCES OF THE MWA

POPULATION

The decade of the 1960's witnessed a tremendous growth in population in the MWA. From 2.1 million people in 1960, the Washington Standard Metropolitan Statistical Area (SMSA) grew to a total population of 2.9 million in 1970 as shown in Table A-13. The 38 percent growth rate between 1960 and 1970 made Washington the fastest growing large metropolitan area in the Nation. This increase in population in the MWA was, to a great extent, the result of several economic factors: (1) the post-World War II increase in government due to the introduction and administration of new programs, (2) the escalation of the conflict in Southeast Asia, (3) the increased employment opportunities available in the non-governmental sectors, and (4) the location of the MWA at the southern end of the Northeast megalopolis.

TABLE A-12

FISH SPECIES IN THE PATUXENT RIVER SYSTEM

Yellowbelly sunfish	Lepomis auritus
Bluegill sunfish	Lepomis m. macrochirus
Smallmouth bass	Microterus d. dolomieui
Largemouth bass	Microterus s. salmoides
Rainbow trout	Salmo gairdneri
Northern pike	Esox lucius
Channel catfish	Ictalurus punctatus
Pickerel	Esox niger
River chub	Hybopsis micropogen
Creek chubsucker	Erimyzon o. oblongus
Stoneroller minnow	Campostoma a. anomalum
Cutlips minnow	Exoglossum maxillingua
Blunt-nosed minnow	Pimiphales notata
Common shiner	Notropis hudsonius amarus
Rosyface shiner	Notropis rubellus
Swallowtail shiner	Notropis procne
Margined Madtom	Shilbeodes m. marginatus
Fantail darter	Etheostoma flabellare
Mottled sculpin	Cottus bairdi
Blacknose dace	Rhinichthys atratulus
Longnose dace	Rhinichthys cataractae
Northern Hogsucker	Hypentelium nigricans
Margined madtom	Notorus insignis
Redside dace	Clinostomus elongata
Stripedback darter	Percina notogramma (very rare)

SOURCE: R. J. Nansuety. Masters thesis: An Ecological and Distributional Study of the Fishes of the Patuxent River Watershed, Maryland (1950). Updated by Maryland Fisheries Administration.

These various growth stimuli resulted in an average annual population increase of 4.5 percent for the 1950-1970 period. Effects of this expansionary era continued into the early 1970's. By the mid-point of the decade, however, changes in the economic climate began to manifest themselves in the MWA through dramatic slowdowns in the rate of growth. This sharp decline in the rate of growth in the 1970's can be attributed to several factors: (1) the economic recession of the early 1970's, accompanied by (2) high interest rates discouraging in-migration, (3) public opposition to proposed major development in the area, and (4) water quality problems resulting in moratoria on water and sewer connections. In some instances, the aforementioned factors were not only a reaction to the tremendous growth of the previous decade but also a result of that same growth.

The rate of growth in the 1970's was considerably less than that of the previous decade. Decennial census results presented in Table A-13 indicate that the 1970-1980 population increase translated into a ten year growth rate of approximately 5.2 percent - compared to the 38 percent growth rate of the previous decade. Indeed, the urban core areas of Washington, D.C., Arlington, Alexandria, and Falls Church lost population but the developing tendencies in the perimeter counties helped to offset these population losses. Since the 1980 census, growth in the MWA has not appreciably changed. The continued decrease in the Federal workforce and the severe recession in the early 1980's combined to cause workforce contraction, tight money supply and high interest rates, and slowdowns in housing construction, resulting in little net in-migration to the area.

EMPLOYMENT

With the conclusion of World War II, the United States realized a period of tremendous employment growth. The 1950-1970 period saw total non-agricultural employment for the Nation increase more than 58 percent -- from 44,321,000 in 1950 to 70,299,000 in 1970. The MWA, the center of the Nation's government, was also positively affected by this tremendous growth in post-World War II employment. While the country was realizing a 20 percent increase in total non-agricultural employment for the 1950-1960 period, the MWA itself realized a 17 percent increase in employment for the same period. The decade of the 1960's witnessed a 55 percent increase in total non-agricultural employment in the Metropolitan Area -- far surpassing the Nation's 31 percent increase in total non-agricultural employment for the 1960-1970 period. Tables A-14 and A-15 present estimates of the total non-agricultural employment and growth rates for the Nation and the Washington, D.C. SMSA, respectively. More recent estimates of employment reflective of the 1980 census were not available for inclusion in this report.

While non-agricultural employment within the Metropolitan Washington Area was increasing, there was an associated reallocation of employment among sectors (e.g. manufacturing, services) as shown on the percentage distribution chart in Table A-16. The Federal Government and the Services sectors are indicative of this employment reallocation.

TABLE A-13

HISTORICAL POPULATION GROWTH
METROPOLITAN WASHINGTON SMSA
(1950-1980)

	YEAR				AVERAGE ANNUAL PERCENT CHANGE		
	1950	1960	1970	1980	1950-1960	1960-1970	1970-1980
District of Columbia	802,178	763,956	756,668	637,651	-0.48	-0.10	-1.57
Charles County	23,415	32,572	47,678	72,751	3.91	4.64	5.23
Montgomery County	164,401	340,928	522,809	579,053	10.74	5.33	1.08
Prince Georges County	194,182	357,395	661,719	665,071	8.40	8.52	0.05
Alexandria	61,787	91,023	110,927	103,217	4.73	2.19	-0.69
Arlington County	135,449	163,401	174,284	152,599	2.06	0.67	-1.24
Fairfax County*	98,557	275,002	477,002	616,291	17.90	7.34	2.92
Falls Church	7,535	10,192	10,772	9,515	3.53	0.57	-1.17
Loudoun County	21,147	24,549	37,150	57,427	1.61	5.13	5.46
Prince William County**	22,612	50,164	111,102	166,665	12.18	12.15	5.00
TOTAL	1,531,626	2,109,182	2,910,111	3,060,240	3.77	3.80	0.52

* City of Fairfax is included in Fairfax County total.

** Cities of Manassas and Manassas Park are included in Prince William County totals.

SOURCE: U.S. Bureau of the Census, Census of Population, *1960*, *1970*.
U.S. Bureau of the Census, Census of Population and Housing, Final Population and Housing Unit Counts, Advance Reports, March 1981.

TABLE A-14

UNITED STATES NON-AGRICULTURAL EMPLOYMENT
1950 - 1974
(1,000's)

	YEAR				AVERAGE ANNUAL PERCENT CHANGE		
	1950	1960	1970	1974	1950 - 1960	1960 - 1970	1970 - 1974
Federal Government	1,928	2,270	2,731	2,724	1.77	2.03	-0.06
Services	5,382	7,423	11,621	13,506	3.79	5.65	4.05
Retail Trade	6,868	8,388	11,225	12,751	2.21	3.38	3.40
State, Local Government	4,098	6,083	9,830	11,560	4.84	6.16	4.40
Construction	2,333	2,885	3,536	3,985	2.37	2.26	3.17
F.I.R.E.[1]	1,919	2,669	3,687	4,161	3.91	3.81	3.21
T.C.U.[2]	4,034	4,004	4,504	4,699	-0.07	1.25	1.08
Manufacturing	15,241	16,796	19,349	20,016	1.02	1.52	0.86
Wholesale Trade	2,518	3,004	3,816	4,259	1.93	2.70	2.90
TOTAL	44,321	53,522	70,299	77,661	2.07	3.13	2.62

[1] Finance, Insurance, Real Estate
[2] Transportation, Communications, Utilities

SOURCE: Cooperative Forecasting Technical Memorandum No. 2, Table III-2, MWCOG, May 12, 1976.

TABLE A-15

MWA NON-AGRICULTURAL EMPLOYMENT*
1950-1974

	YEAR				AVERAGE ANNUAL PERCENT CHANGE		
	1950	1960	1970	1974	1950-1960	1960-1970	1970-1974
Federal Government	260,200	238,200	319,100	337,300	-0.84	3.40	1.42
Services	85,300	137,800	252,600	300,500	6.15	8.33	4.74
Retail Trade	100,200	122,400	187,900	205,200	2.21	5.35	2.30
State, Local Government	34,600	56,100	132,300	155,800	6.21	13.58	4.44
Construction	39,700	50,800	67,800	88,700	2.79	3.35	7.71
F.I.R.E.[1]	31,500	41,100	68,000	79,200	3.05	6.54	4.12
T.C.U.[2]	43,000	45,100	60,200	66,500	0.49	3.35	2.62
Manufacturing	28,300	35,300	44,700	48,600	2.47	2.66	2.18
Wholesale Trade	21,500	26,800	38,100	42,400	2.46	4.22	2.82
TOTAL	644,300	753,600	1,170,700	1,324,200	1.70	5.53	3.28

SOURCE: Cooperative Forecasting Technical Memorandum No. 2, Table III-1, MWCOG, May 12, 1976

* Totals rounded to the nearest hundred, include Charles County.

[1] Finance, insurance, real estate.

[2] Transportation, communications, utilities.

TABLE A-16

DISTRIBUTION OF TOTAL NON-AGRICULTURAL EMPLOYMENT
IN METROPOLITAN WASHINGTON *
(1950-1974)

	1950	1960	1970	1974
Federal Government	40.4%	31.6%	27.3%	25.5%
Services	13.2%	18.3%	21.6%	22.7%
Retail Trade	15.5%	16.2%	16.1%	15.5%
State, Local Government	5.4%	7.4%	11.3%	11.8%
Construction	6.2%	6.7%	5.8%	6.7%
F.I.R.E.	4.9%	5.5%	5.8%	6.0%
T.C.U.	6.7%	6.0%	5.1%	5.0%
Manufacturing	4.4%	4.7%	3.8%	3.7%
Wholesale Trade	3.3%	3.6%	3.3%	3.2%
TOTAL	100%	100%	100%	100%

(Column summations may not agree with total due to rounding).

* Includes Charles County

SOURCE: Cooperative Forecasting Summary Report -- 1976,
Metropolitan Washington Council of Governments, December 1976.

In 1950, the Federal Government employed over 40 percent of the non-agricultural job-holders in the MWA. By 1974, approximately 25 percent of the non-agricultural job-holders were employed by the Federal Government - continuing a steady decline in the sector's share of total non-agricultural employment. The decrease in the Federal Government's share of total non-agricultural employment is not surprising when several developments are considered:

(1) Due to employment opportunities, income gains, and individual expectations, population was attracted to the suburban areas.

(2) This growth in suburbia led services and retail institutions to expand.

(3) The Federal Government increased contractual dealings with private industry.

These developments placed increased demands on local government and led to a realignment of the work force toward the private sector.

The Services sector increased its share of total non-agricultural employment from 13 percent in 1950 to almost 23 percent in 1974. Together, the Federal Government and Services sectors employed almost 50 percent of the non-agricultural job-holders in 1974. Table A-16 indicates that the relative shares of Federal Government; Transportation, Communications, Utilities (T.C.U.); and Trade decreased while the following sectors increased their relative shares of total non-agricultural employment: Finance, Insurance, Real Estate (F.I.R.E.); Services; and State and Local Government. Figure A-20 compares 1974 employment in the MWA with the National distribution.

The MWA has had a tradition of low unemployment, normally well below the National average. In 1960, 2.7 percent of the labor force in the MWA was unemployed while 5.5 percent of the Nation was unemployed. In 1970, according to the Bureau of Labor Statistics, the unemployment rate was 3.1 percent for the MWA while the unemployment rate for the Nation was 4.9 percent. In the spring of 1977, unemployment was just under 5 percent for the MWA and approximately 7 percent for the Nation. While the unemployment rate in the MWA is increasing, it appears that the MWA is somewhat insulated from the effects of National trends.

Per capita income is the best single indicator in analyzing the economic conditions of an area's population. The MWA has shared in the general rise of per capita income that has characterized the U.S. economy since the end of World War II. There are several factors which have contributed to the income gains experienced in the MWA: (1) improvement of Federal wages; (2) an increase of highly-skilled and professional occupations; and (3) a low rate of unemployment.

After reviewing the information on the Metropolitan Washington Area and comparing it with the Nation as a whole, one fact is evident: the unique nature of the MWA is largely attributable to the role of the Federal Government. However, while the direct contribution of the Federal Government to total non-agricultural employment has decreased, its importance to the regional economy has not.

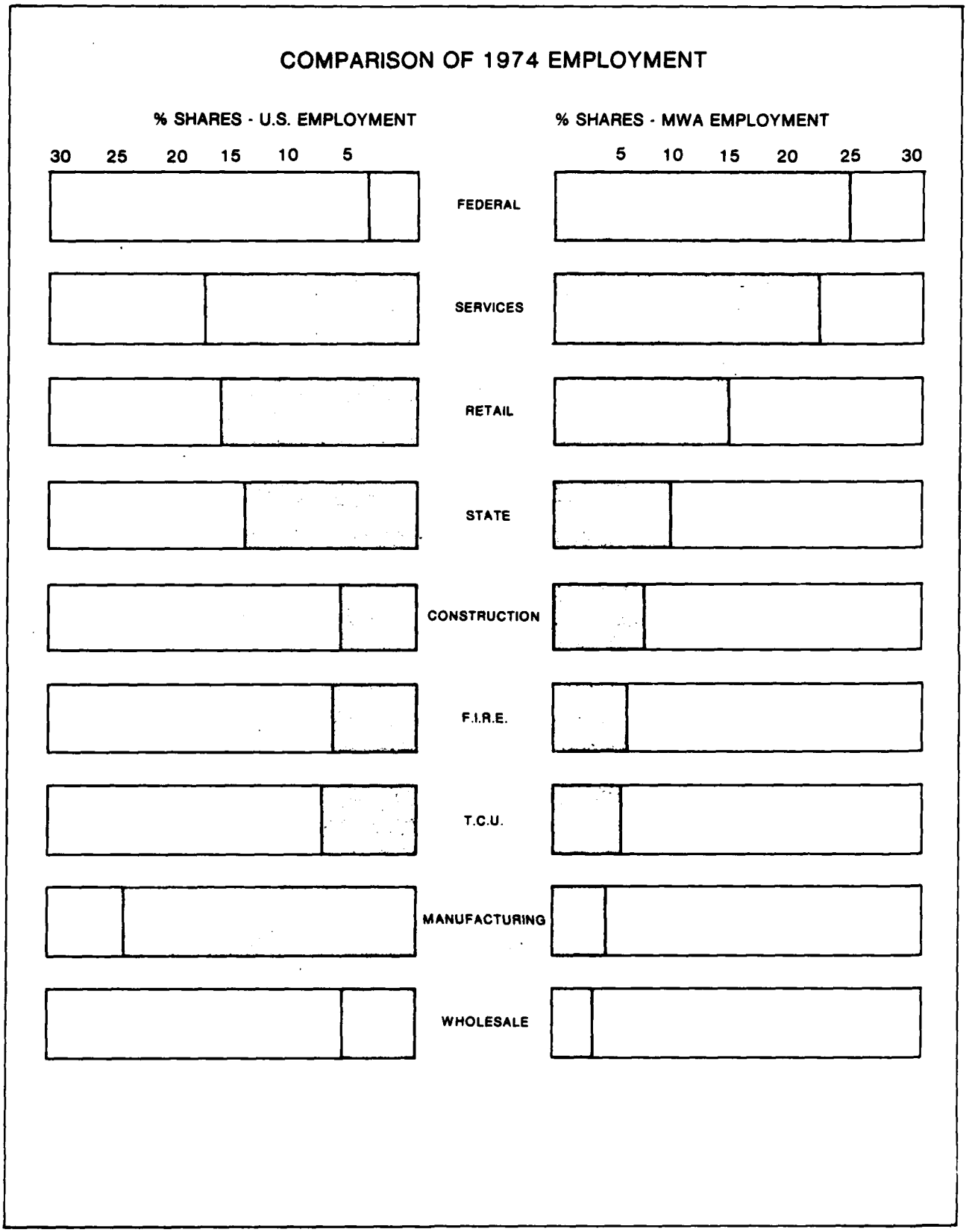

COMPARISON OF 1974 EMPLOYMENT
% SHARES - U.S. EMPLOYMENT
30 25 20 15 10 5
% SHARES - MWA EMPLOYMENT
5 10 15 20 25 30
FEDERAL
SERVICES
RETAIL
STATE
CONSTRUCTION
F.I.R.E.
T.C.U.
MANUFACTURING
WHOLESALE

FIGURE A-20

HOUSING

As a consequence of the increased employment opportunities in the Metropolitan Washington Area in the 1960's, a substantial demand was placed on the area's housing market. This demand was realized because of the influx of new inhabitants coupled with the availability of easy mortgages. Occurring in the suburban areas contiguous to the District of Columbia, development realized a growth of 287,600 households in the 1960-1970 period. This represented a 46 percent increase over the 623,000 households in the area in 1960.

As shown in Table A-17 the larger and relatively less developed areas in the MWA (namely, Prince Georges, Fairfax, and Prince William Counties) experienced the greatest increase in households.

Household size is also one of the influences on demand for housing. In the Metropolitan Washington Area, the trend has been toward decreasing household size. The decade of the 1960's witnessed an increase in the proportion of smaller households to the total number of households while, over the same period, the number of persons per household declined from 3.3 persons in 1960 to 3.0 persons in 1970. This trend in declining household size is a reflection of the following developments in the MWA: (1) the increasing number of one-person households; (2) the growth of new households of unrelated persons; (3) the expansion of the Metropolitan Washington Area economy providing jobs and generating gains in income which encourages a decrease in the number of people per household; and (4) the growth in apartments and new town developments encouraging smaller family size. Although 1980 census data on households were not yet available, indications are that the number of persons per household has continued to follow the trend. Pre-1980 demographic analyses estimated that the 1980 average household size in the MWA would approximate 2.85 persons for household.

Accompanying this decrease in household size has been an increase in the number of housing units in the MWA. The twenty years since the 1960 census has seen housing units increase more than 550,000, almost doubling the 1960 stock. The last decade (1970-1980) showed a relatively modest increase in housing stock of 25 percent. There is no doubt that the economic conditions of the 1970's played a role in the slower rate of increase as well as, perhaps, the household composition discussed above. Information on the number of housing units is presented in Table A-18.

EDUCATIONAL RESOURCES

In 1970, the Area's median school years completed was 12.6 which was 0.4 years greater than the average for all Standard Metropolitan Statistical Areas (SMSA's) of 200,000 people or more. The MWA also exceeded the Nation's average of 12.1 median school years completed by 0.5 years.

Only 2.9 percent of the population aged 25 and over had failed to complete more than four years of school in 1970, contrasted to 4.8 percent for SMSA's of 200,000 people or more and to the national average of 10.7 percent. In the same age group, 23.4 percent of the population of the MWA had completed four years or more of college compared to 12 percent in SMSA's of 200,000 people or more. Thus, in every educational parameter, the MWA exceeds the average of SMSA's larger than 200,000 as well as the national average.

TABLE A-17

NUMBER OF MWA HOUSEHOLDS
1960-1970
(1000's)

	1960	1970	PERCENT CHANGE
Charles County	8	12	50.0
Montgomery County	92	157	70.6
Prince Georges County	95	193	103.1
Maryland Suburbs	195	362	85.6
Alexandria City	30	42	40.0
Arlington County	57	69	21.0
Fairfax County*	69	136	97.1
Loudoun County	7	10	42.8
Prince William County	13	28	115.4
Virginia Suburbs	176	285	61.9
District of Columbia	252	263	4.4
Metropolitan Area	623	910	46.1

* Include the Cities of Fairfax and Falls Church

SOURCE: Northeastern United States Water Supply (NEWS) Study, Annex D, Volume 2, Table T-8, November 1975.

TABLE A-18

NUMBER OF MWA HOUSING UNITS
(1960-1980)

				AVERAGE ANNUAL PERCENT CHANGE	
	1960	1970	1980	1960-1970	1970-1980
Charles County	7,740	13,577	22,721	7.54	6.73
Montgomery County	92,433	161,378	216,221	7.46	3.40
Prince Georges County	94,995	200,637	236,465	11.12	1.78
Maryland Suburbs	195,168	375,592	475,407	9.24	2.66
Alexandria	29,754	44,421	52,041	4.93	1.71
Arlington County	56,949	71,241	75,182	2.51	0.55
Fairfax County	65,563	130,508	215,739	9.90	6.53
Fairfax	3,621	6,574	7,050	8.15	0.72
Falls Church	2,894	3,762	4,503	3.00	1.97
Loudoun County	7,370	11.381	19,742	5.44	7.35
Prince William County*	13,207	29,885	53,932	12.63	8.05
Virginia Suburbs	179,358	297,772	428,189	6.60	4.38
District of Columbia	252,066	278,327	276,707	1.04	-0.06
TOTAL MWA	626,592	951,691	1,180,303	5.19	2.40

SOURCE: 1967 County and City Data Book, U.S. Department of Commerce, Bureau of the Census, 1967.

1980 Census of Population and Housing, Advance Reports, Final Population and Housing Unit Counts, U.S. Department of Commerce, Bureau of the Census, 1981.

Tremendous educational opportunities exist in the MWA as a result of the programs available at the various area colleges and universities. In Prince Georges County are located Bowie State College and the University of Maryland at College Park. In the Commonwealth of Virginia, the Northern Virginia Community College has educational facilities located in the various jurisdictions; community colleges also support educational activities in Charles County, Montgomery County, and Prince Georges County. The District of Columbia, by far, contains the greatest amount of educational institutions in the MWA. Some of these are George Washington University, Catholic University of America, Georgetown University, and American University.

CULTURAL RESOURCES

The MWA is also an area of archeological and historical interest. It has been construed that large aboriginal populations occupied this area almost continuously up to and including the period of the European settlement. This has resulted in the presence of a considerable amount of prehistorical and historical resources.

The prehistoric cultural periods are termed Paleo-Indian, Archaic, Transitional, and Woodland. They cover a time span from pre-8000 B.C. to the European Contact, and demonstrate a variety of life styles ranging from hunter-oriented during the Paleo-Indian period to that of a horticultural and a more sedentary way of life to the European Contact. Indian groups in the study area at this time included the Tuscororas, Shawnees, Nanticoke, Piscataway, and Susquehannock. Only a few of these late contact sites have been excavated.

In the MWA, the Paleo-Indian cultures are typically found on high terraces and upland ridges in all areas of Maryland and Virginia. The Archaic cultures range from small isolated camps in the Piedmont and Blue Ridge regions to areas where the remains of intermittent occupation sites cover long stretches of the Potomac River floodplain. Transitional cultural people occupied slightly larger sites in the floodplains, and early and middle Woodland peoples occupied seasonal camps, villages, quarry sites and cemeteries which were located along rivers, tributaries, and the Chesapeake Bay shoreline terraces. Oyster shell middens from the Woodland period have been found along the Bay and its estuaries.

The historical development of Fairfax and Loudoun Counties in Virginia; Montgomery and Prince Georges Counties in Maryland; and the District of Columbia reflects the Nation's heritage, beginning with the early explorers, homesteaders, plantation planters, colonists, and the early and contemporary commercial enterprises, including activities which reflect the growth of the Nation's center of government. This is evidenced by the fact that the study area had basically remained rural in character with an agriculturally-oriented economy until the Civil War troop movements. These military activities contributed significantly to further economic development. The historical significance of the study area is further indicated by the more than 300 places in the region on the National Register of Historic Places. These historic places cover a wide variety of houses, memorials, places of historic events, and historical districts. More recently, rapid growth of the Federal Government during and after World War II has changed the core of the MWA into a major urban metropolitan region.

RECREATIONAL RESOURCES

Within and nearby the MWA a variety of recreational facilities are available ranging from Federal parks to local community recreation centers. At the Federal level, there are three nearby national parks, one national forest, and several small parks and open space areas. These are presented in Table A-19. Table A-20 presents the State parks and forests located in and around the area.

There are two local regional park authorities within the study area, the Maryland-National Capital Park and Planning Commission (M-NCPPC) and the Northern Virginia Regional Park Authority. The Commission serves Montgomery and Prince Georges Counties in Maryland and the Authority serves Arlington, Fairfax, and Loudoun Counties and the Cities of Alexandria, Falls Church, and Fairfax in Virginia. These regional park entities plan, acquire, develop, operate, and maintain a system of regional parks to preserve forests, meadows, lakes, and streams, while providing needed outdoor recreation. These are presented in Table A-21. The Commission also provides a system of smaller parks and community recreation centers.

Recreational facilities are also provided for by local governments. These facilities include small parks, community athletic fields, and the use of the athletic and recreation facilities at local schools. In Montgomery and Prince Georges Counties, the amount of locally-sponsored recreation is at a minimum since the M-NCPPC provides for the local facilities in addition to the larger regional parks. The Virginia counties generally provide their own recreational facilities. Even though the District of Columbia provides various athletic fields and playgrounds, District residents rely heavily on the Federal parks and open space area for their outdoor recreation facilities.

In addition to the recreation facilities offered by the Federal, state, and local governments, a few recreational areas are provided by non-governmental concerns. The Washington Suburban Sanitary Commission operates and maintains the Triadelphia-Rocky Gorge Reservoirs. These two reservoirs offer a wide variety of water-oriented activities to the surrounding area. In addition, Little Seneca Lake, due to be completed in 1985, will be provided with picnic areas, hiking trails, and boating facilities jointly administered by WSSC and M-NCPPC.

To meet the increasing demand for recreation facilities, the Federal, state, and local governments have planned for further acquisition of land for recreation use by expanding their existing facilities and by acquiring new recreation areas. The C & O Canal National Historic Park has initiated the process to purchase an additional 1,800 acres of privately owned land within the boundaries of the Canal Park. The State of Maryland plans to expand the Patuxent State Park by 2,000 acres, Seneca by 2,300 acres, and Rosaryville by 160 acres. Virginia plans to develop a State park in the Bull Run Mountain area, a State forest in Prince William County, and to expand their existing park and forest areas.

On the regional level, the M-NCPPC has five regional parks in Montgomery County and one regional park in Prince Georges County in various stages of development. The Northern Virginia Regional Parks Authority has five regional parks, one of them by the Occoquan. The District of Columbia plans to increase its local community facilities by 1,100 acres. In addition, some 3,500 acres of Federally-owned land will be used as local recreation parks.

TABLE A-19

NATIONAL PARKS IN METROPOLITAN WASHINGTON AND SURROUNDING AREAS

NAME	ACRES	LOCATION	FACILITIES
Chesapeake & Ohio Canal National Historic Park	7,000	Along 37 miles of Potomac from Washington, D.C. to Frederick County line in Maryland.	Biking, hiking, boating, fishing, nature study.
Shenandoah National Park	12,657	Warren County, Virginia.	Hiking, fishing, picnicking, camping. Parts of Appalachian Trail and Skyline Drive are located in the park.
George Washington National Forest	6,000	Warren County, Virginia.	Camping, hiking.
Prince William Forest Park	17,000	Prince William County, Virginia.	Hiking, picnicking, camping.
Various parks, squares, circles, and open space areas.	7,000	Washington, D.C.	Biking, picnicking, hiking.

SOURCE: Commission of Outdoor Recreation, The Virginia Outdoors Plan (1978); Warren County, Comprehensive Plan (1975); Baltimore District, Corps of Engineers, Metropolitan Washington Area Water Supply Study-Background Information Appendix (1978); National Capital Planning Commission, Comprehensive Plan for the National Capital (1974).

TABLE A-20
STATE PARKS AND FORESTS
IN METROPOLITAN WASHINGTON AND
SURROUNDING AREAS

NAME	ACRES	LOCATION	FACILITIES
Seneca State Park	4,297	Montgomery County, Maryland.	Hiking, picnicking.
Patuxent River State Park	5,971	Montgomery and Howard Counties, Maryland.	Hiking, picnicking,
Rosaryville State Park	977	Prince Georges County, Maryland	Camping, hiking, nature study, fishing.
Chapel Point	328	Charles County, Maryland.	Historic, picnicking.
Purse	148	Charles County, Maryland.	Hiking, picnicking
Doncaster	1,485	Charles County, Maryland.	Hiking, camping.
Greenwell	605	St. Mary's County, Maryland.	Hiking, picnicking.
St. Mary's River	1,936	St. Mary's County, Maryland	Water-oriented activities.
Point Lookout	517	St. Mary's County, Maryland	Water-oriented activities.
G.W. Grist Mill	7	Fairfax County, Virginia	Hiking, historical.
Sky Meadows	1,100	Fauquier County, Virginia	

Source: Commission of Outdoor Recreation, The Virginia Outdoors Plan (1978); Maryland Department of Natural Resources Listing of State Parks and Forests in Maryland, (1978).

TABLE A-21

REGIONAL PARKS IN THE METROPOLITAN WASHINGTON AREA

TYPES	ACRES	LOCATION	FACILITIES
Regional parks (4 developed and 5 partially developed) and 160 local parks and community centers	21,000	Montgomery County, Maryland.	Camping, picnicking, biking, lake activities, athletic facilities, nature centers.
Regional parks (2 developed) with 200 local parks and community recreation centers	14,000	Prince Georges County, Maryland.	Same as above.
Regional parks (9 developed)	8,000	Northern Virginia.	Same as above (two of the regional parks have water-oriented activities at the Occoquan Reservoir).

SOURCE: Northern Virginia Regional Park Authority, Plan and Program for Regional Parks in Northern Virginia (1977); Maryland-National Capital Park and Planning Commission, Parks and Recreation Inventory Pamphlet for Prince Georges and Montgomery Counties (1977).

The individual counties have also planned to provide additional parks and community centers in areas that have inadequate facilities. These areas are usually in the parts of the counties that have experienced the most urban growth.

TRANSPORTATION

The MWA is traversed by various ground and air routes, as indicated by Figure A-21, and receives waterborne commerce through several ports. Numerous Interstate and U.S. Routes are located in the study area. Interstates 95 and 66 and U.S. Routes 50 and 301 are major highways. Other ground facilities include parkways, railroads, and motor freight carriers. In addition to the public bus facilities, a regional rapid rail system has been constructed in the MWA. Air facilities serving the major air carriers are located at Dulles International Airport and Washington National Airport while port facilities are available at Alexandria and Washington, D.C.

GROWTH AND DEVELOPMENT

Growth patterns within the MWA vary from county to county. As is indicated in Figure A-22, the natural features of the area are an influential growth factor; other factors are a result of socio-economic considerations. No matter what the reason for particular development patterns, these same patterns, to some extent, dictate existing and potential land use and concomitant land values. It is these two areas -- development patterns and land values -- that will be touched upon in this section. Since each jurisdiction within the MWA exhibits slightly differing tendencies, a discussion of development within each of the jurisdictions follows.

MONTGOMERY COUNTY

The majority of the Montgomery County population is concentrated around the District of Columbia in a heavily developed urban ring encompassing such communities as Bethesda, Chevy Chase, Silver Spring, Takoma Park, and Rockville City as indicated in Figure A-23. While these areas are still able to accommodate modest growth, a large portion of the growth presently being experienced is along the Interstate 270 corridor, including the developments of Gaithersburg, Clarksburg, and Germantown. The Colesville area of Montgomery County, which borders part of Prince Georges County, accounts for a small portion of the current development, while communities further removed from the District and the I-270 corridor (Olney, Damascus, Poolesville) are presently experiencing relatively little growth.

A general description of Montgomery County land values (1978) would involve approximately four categories. The most modest prices are found in the extreme western and northwestern end of the County. Considered a rural area, parcels ranging from approximately 5 to 50 acres sell for $5,000 an acre. Due to the lack of sewer systems and soil percolation problems, at least ten acres of land are required to build a single family residence. Little development is occurring in this part of Montgomery County. In the extreme eastern portion of the County, 5-50 acres sells for $6,000-7,000 on the average. In the north and central section of the County development is occurring at a relatively fast pace. Though sewerage is not generally available, soil percolation is

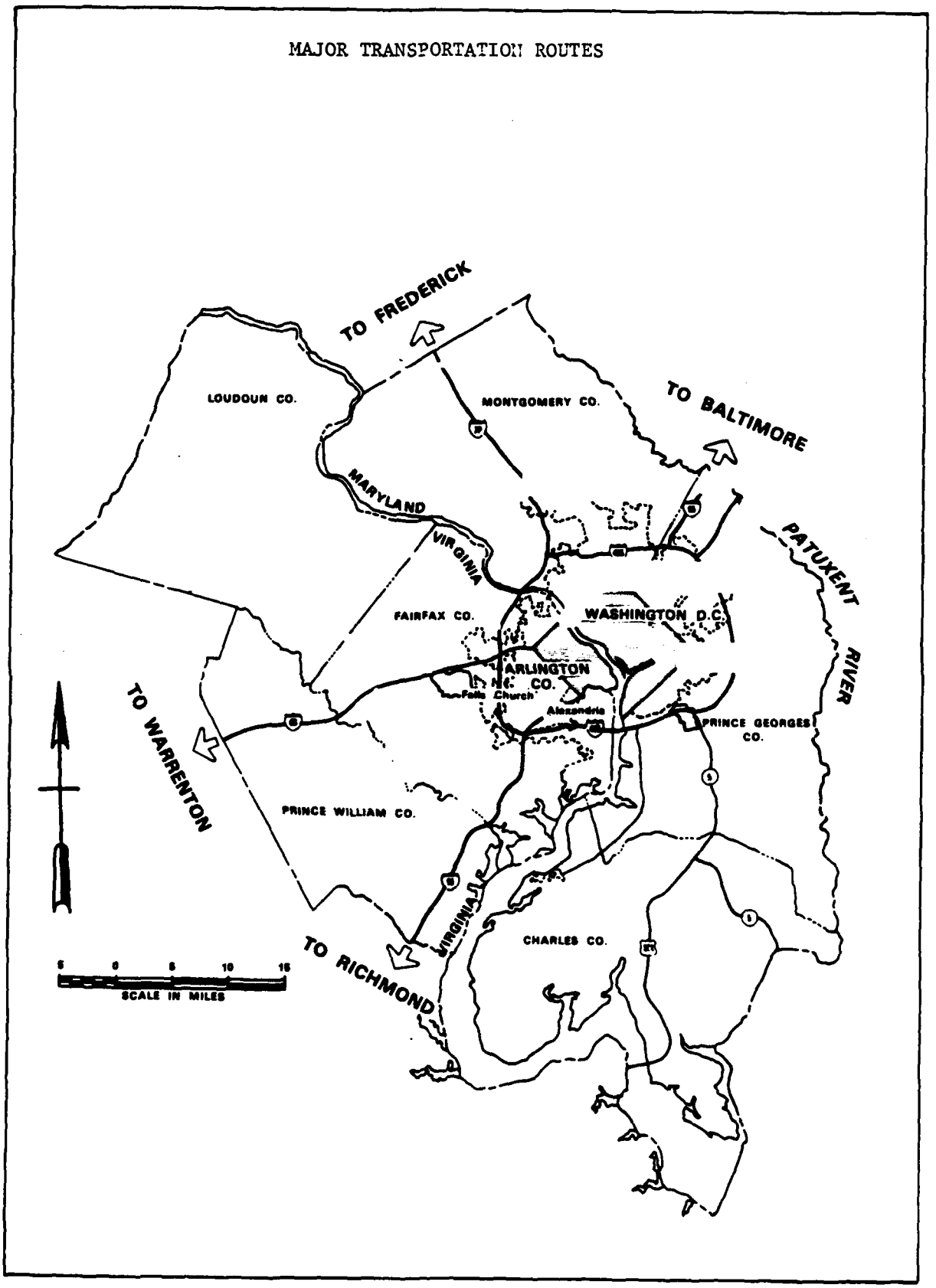

MAJOR TRANSPORTATION ROUTES
TO FREDERICK
TO BALTIMORE
LOUDOUN CO.
MONTGOMERY CO.
MARYLAND
VIRGINIA
PATUXENT RIVER
FAIRFAX CO.
WASHINGTON D.C.
ARLINGTON CO.
Falls Church
Alexandria
PRINCE GEORGES CO.
TO WARRENTON
PRINCE WILLIAM CO.
VIRGINIA
CHARLES CO.
TO RICHMOND
5 0 5 10 15
SCALE IN MILES

FIGURE A-21

Land Use - MWA

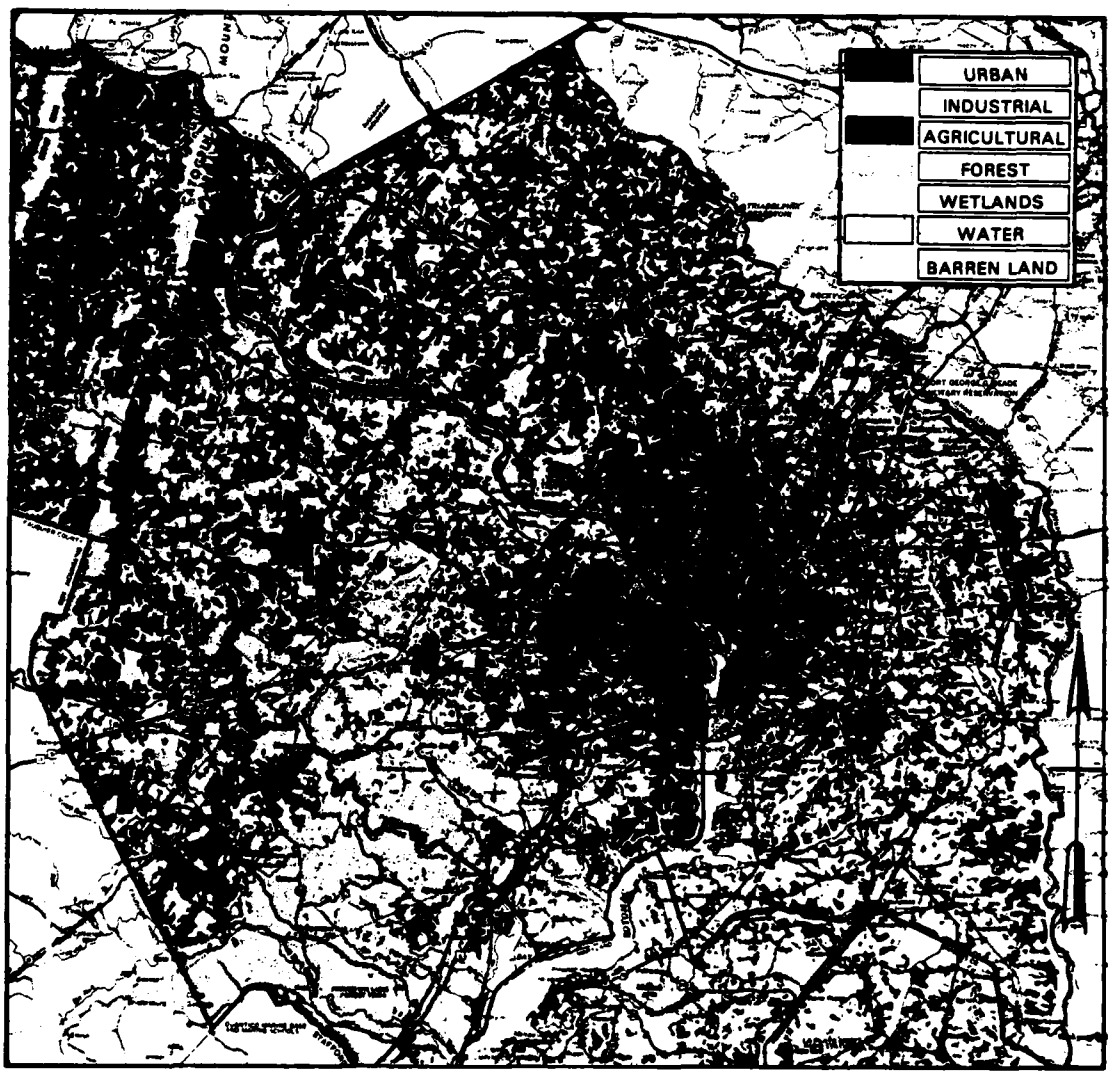


FIGURE A-22

Source: M-NCPPC Ten Year Water Plan

GROWTH FORECAST & PLANNING AREAS IN MONTGOMERY COUNTY

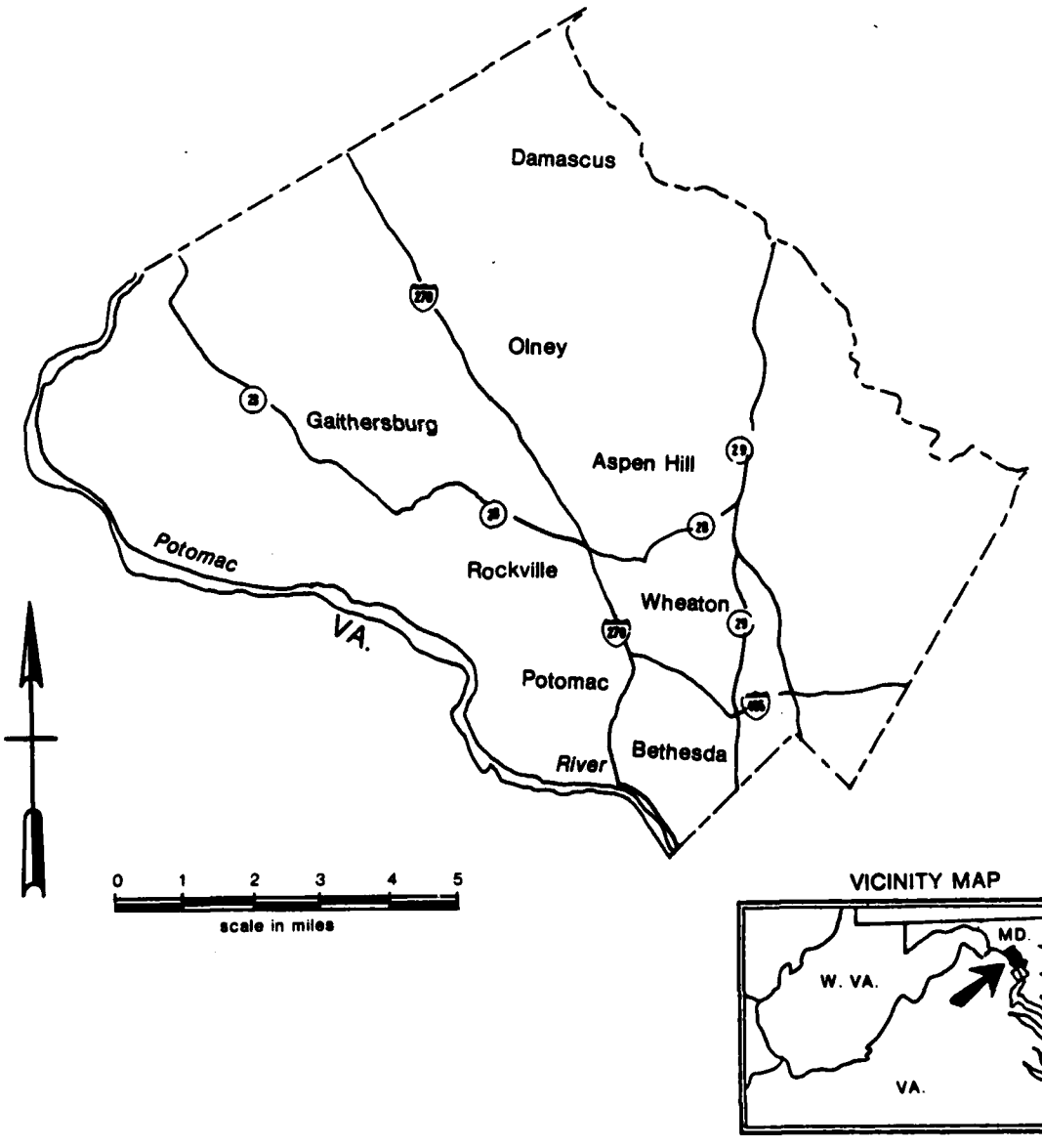


FIGURE A-23

good. The average one-half to two acre lot starts at $22,000 in this area and the average home costs $80,000 to construct. Land by the Interstate 270 interchanges has special development potential and usually starts at $27,000 per lot. The medium lot price for land is approximately $35,000 in urban developments closer to the District like Silver Spring, Wheaton, and Rockville. The most expensive lots border the western District line and the southern end of Montgomery County along the Potomac River. Development activity is not as intense here. Lots of 6,000 to 9,000 square feet in Bethesda, for example, are valued at $60,000-$100,000. A similar situation exists in Chevy Chase. A little farther out from the District in communities like Potomac and Darnestown lots of one-half to 2 acres cost $80,000-$100,000. Homes in this exclusive area are in the $250,000-$500,000 range. Industrial land sales normally vary from $2 to $10 per square foot, while commercial sales occur in the $3-$25 per square foot range. Montgomery County has much prime real estate for development. Only about one-sixth of the land is assigned to public use and much of it consists of parks scattered throughout the County which enhance suburban residential development.

Development projections beyond 1980 indicate that the areas presently experiencing growth will continue to do so, with the outlying areas accommodating an increasing share. The urban ring and the I-270 corridor along with the Olney, Potomac, and Colesville areas have major development potential with differing degrees of density. The central business districts, the transit station areas in the I-270 corridor, and the down county area will witness high densities, while moderate densities are expected in the I-270 corridor and the remaining zoned area within the urban ring. Included in these areas are the new developments of Montgomery Village, Rossmoor, and Snowden Mill. Outer areas of Montgomery County will tend to decrease in density where large lot zoning currently exists.

The Washington Metropolitan Area Transit Authority is presently operating a rapid rail transit system which is in varying phases of operation. Two of the routes extend into Montgomery County with terminal stations located at Glenmont and Shady Grove. When operationally complete, 11 transit stations will be located in Montgomery County, each with moderate to high density potential.

PRINCE GEORGES COUNTY

Development in the Prince Georges area is presently concentrated within the Capital Beltway (I-495) in communities such as Oxon Hill, Suitland, Hyattsville, Bladensburg, and Marlow Heights. The northeastern portion of the County is presently more developed than the southern area, with the major concentration of population generally following the corridor between Baltimore and Washington. Located within this corridor are several large government and institutional facilities such as the National Agricultural Research Center, Goddard Space Flight Center, and the University of Maryland at College Park. The eastern border of the County, which is formed by the Patuxent River, is relatively underdeveloped. Portions of this area are designated as park land and wildlife reserves. Communities that are located in this eastern section such as Laurel, Bowie-Belair, and Upper Marlboro are also situated around established and well-travelled highway routes. The southern portion of the County is less heavily developed; several communities parallel highway routes; lands along the highways are utilized for agricultural purposes while Andrews Air Force Base and several military reservations are also situated there.

Development in Prince Georges County will continue in the northeastern corridor between Washington and Baltimore with several rapid rail routes contributing modestly

to this development. The southern half of the County, around the Capital Beltway, will be a major new development area. Some presently emerging communities such as Largo and Clinton, indicated in Figure A-24, will experience additional development in a low to moderate density range, while the community of Upper Marlboro, designated as an expanded new town, will experience relatively low density. The planned community of Mattawoman, bordering Charles County, will accommodate modestly dense development. Large portions of the southern half of Prince Georges County will remain rural, reflecting large lot and rural subdivision concerns while the conservation areas will include agricultural land, park land, and estate development with no plans for future urbanization.

The Washington Metropolitan Area Transit Authority has four rapid rail routes in Prince Georges County. The terminal stations for these lines are at New Carrollton, Greenbelt Road, Branch Avenue, and Addison Road. As these locations are within the ring of the Capital Beltway, increased densities will probably result from redevelopment.

Prince Georges County is the only other Maryland county that borders the District. A prolonged sewer moratorium was lifted in 1977 which has encouraged an abundance of construction activity. Land values that had remained fairly constant since 1968 have risen noticeably. This burst of activity has developed many of the remaining properties in Prince Georges County.

The tremendous amount of public land in the County restricts the amount of land available for development. Over one-third of the County real estate is considered public land. Occasionally, the Government declares a portion of its land in excess and thereby contributes to the amount of land suitable for development. However, because of developmental limitations, a trend toward renewal development has begun in the County.

Most of the County's real estate is geared to the middle income purchaser. Trends of value (1978) in Prince Georges County can generally be described as follows: land values tend to be lowest inside the Interstate 495 circuit where 5,000-8,000 foot square lots sell for approximately $13,500. The one-quarter acre lot in the County, which is in high demand, has a median price of $15,000. Exclusive high-priced lands are not concentrated in any one area. They are found, for example, in Tantallon and College Park where a few lots are priced at $100,000. Waterfront property along the Potomac may sell for as much as $50,000 per acre. In less densely developed parts of the County, particularly in the southern rural areas, raw backland is available for $2,000 to $3,000 per acre and residential sites sell at $15,000 for the first acre. Industrial parcels sell for $2 to $10 per square foot and commercial parcels can be purchased for $3 to $25 per square foot.

CHARLES COUNTY

Charles County has been and for the most part still is a rural county characterized by farms and undeveloped land. The communities of Indian Head, Waldorf, and LaPlata - all situated around major arterials - account for the majority of the present development. Located in the western portion of the county near Indian Head are the residential areas of Strawberry Estates and Potomac Heights. Several Federal Government installations are also situated in Charles County: the U.S. Naval Ordnance Station on the western border, and the U.S. Army Radio Receiving Station in the northeast portion. Portions of Charles County, pictured in Figure A-25 are bounded by the Potomac, Patuxent, Wicomico, and Mattawoman Rivers, and land contiguous to these rivers is maintained as marsh and wetlands as well as wildlife management areas.

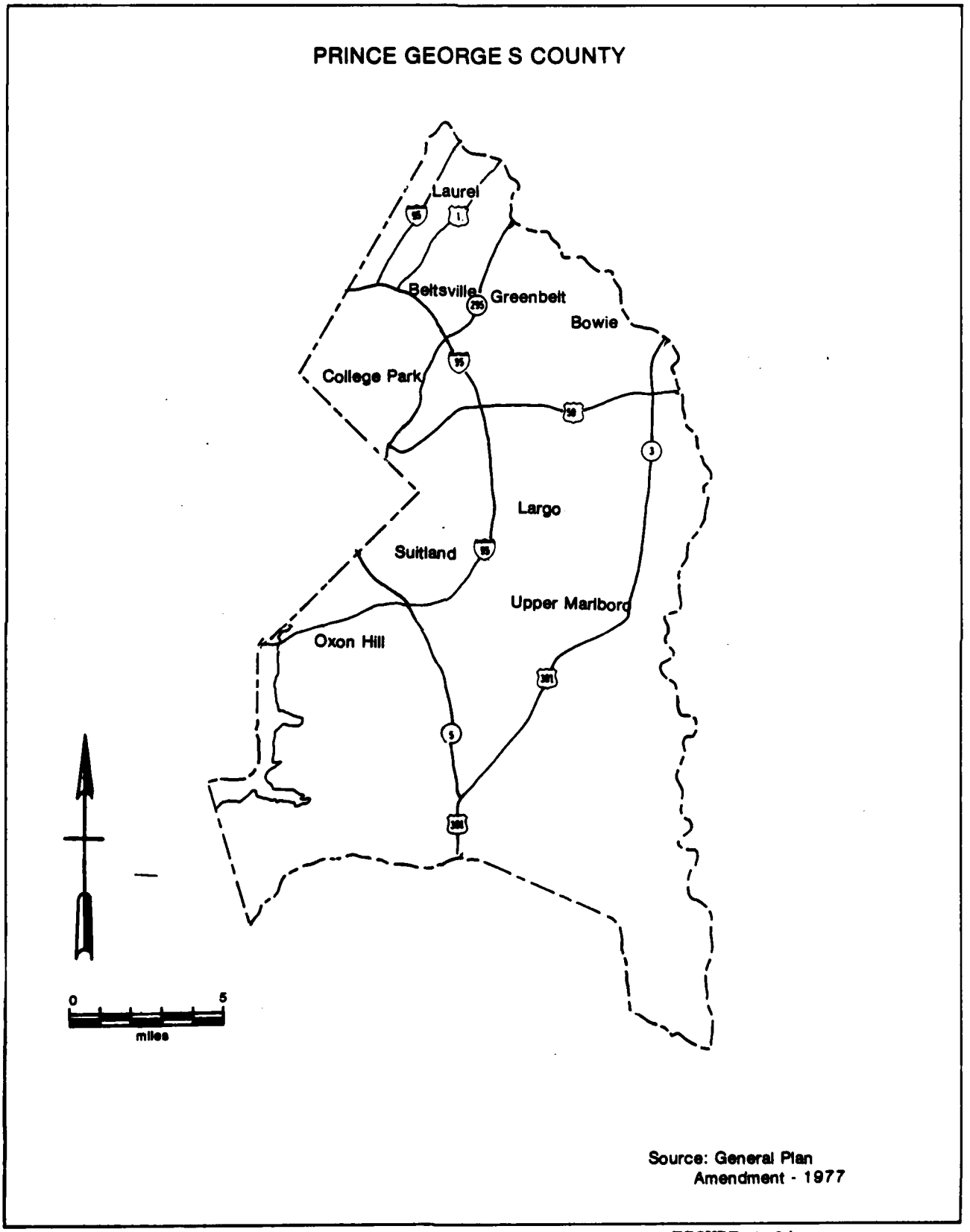

PRINCE GEORGE S COUNTY
Laurel
Beltsville
Greenbelt
Bowie
College Park
Largo
Suitland
Upper Marlboro
Oxon Hill
0
5
miles
Source: General Plan
Amendment - 1977

FIGURE A-24

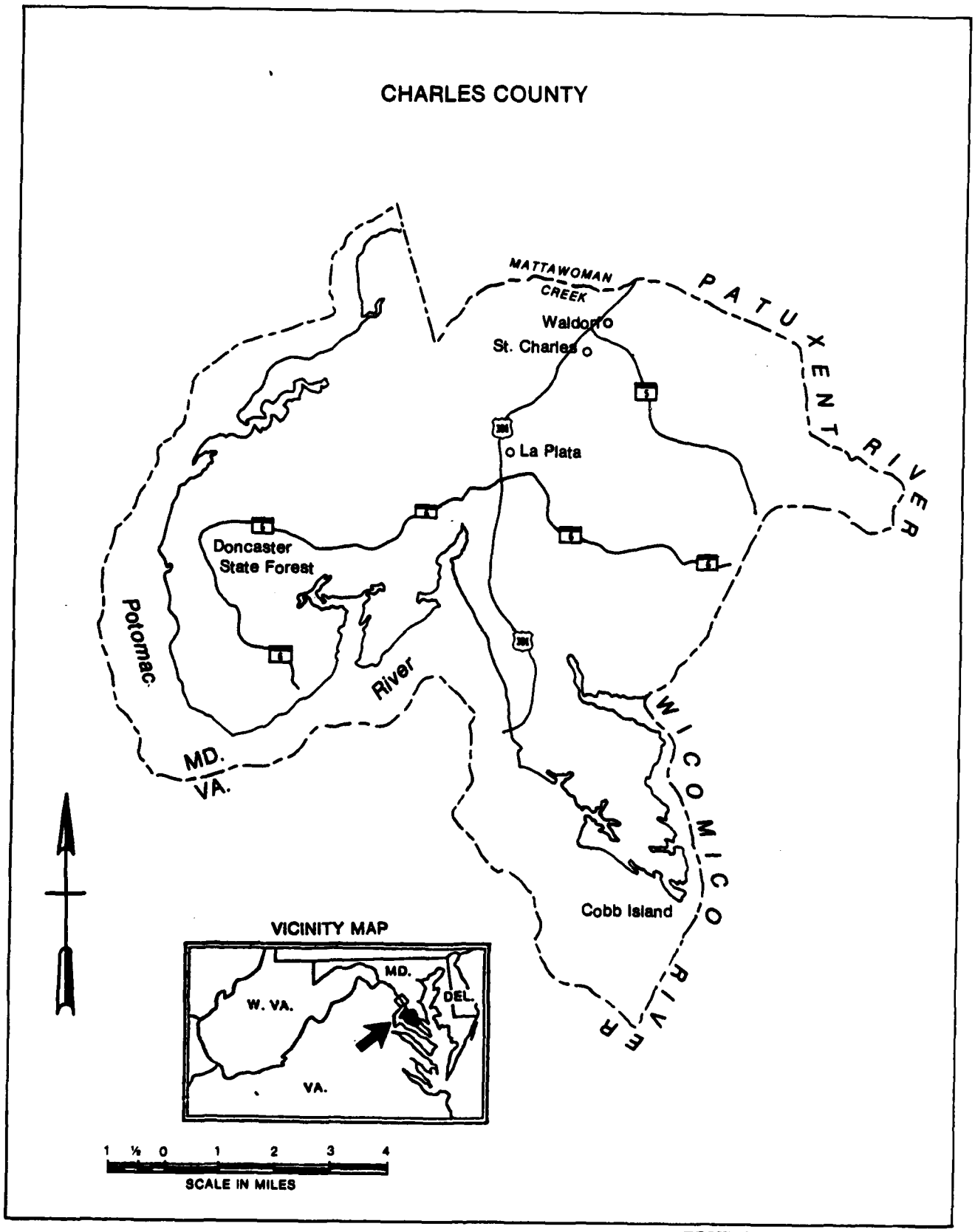

CHARLES COUNTY
MATTAWOMAN CREEK
PATUXENT RIVER
Waldorf
St. Charles
La Plata
Doncaster State Forest
Potomac River
MD.
VA.
WICOMICO RIVER
Cobb Island
VICINITY MAP
MD.
W. VA.
DEL.
VA.
1 ½ 0 1 2 3 4
SCALE IN MILES

FIGURE A-25

Future development will occur in most areas of the County. Because of the topography and the waterfront views, development in the southern portion of the County will be oriented toward retirement homes or second homes. To realize a low to medium population density, growth in this area will be controlled. The eastern section of the County will remain rural and in this way the prime natural features will be maintained along with a goal of low population density.

Owing to its proximity and increased accessibility to the District of Columbia resulting from highway construction, the northern Charles County area has been outlined as the area of expected high density development. With the existing communities of Waldorf, Indian Head, and LaPlata already situated along major transportation corridors, it is intended that this part of the County be guided toward the development of a series of urban centers. The St. Charles Community which is a planned urban development, is already beginning to accommodate this growth.

The County's current real estate picture is determined largely by a zoning program which went into effect in 1974. A new master plan is being developed which may alter this prevailing development attitude. The nature of zoning in Charles County currently keeps intense development concentrated in the aforementioned area of Waldorf and the State Route 301 corridor. Seventy-five percent of the land has been zoned for development of no less than three acres per residence. The market is not affected by the small percentage of public land and no moratoria restrict construction.

Overall, the County real estate market shows a low development intensity and contains much land in the lower range of MWA values (1978). The three acre parcels which make up much of the County are available for $4,000 to $6,000 per acre. Large tracts are available for as little as $1,000 per acre. In the Waldorf and St. Charles area where sewer systems are available, one-third acre parcels can be bought for approximately $13,000-$17,000. Land in these areas without sewerage is available in one-acre parcels for $18,000. The most costly properties are found along the waterfront and sell for approximately $20,000 to $25,000 per acre. Industrial and commercial lands are normally available for $1 to $10 per square foot.

DISTRICT OF COLUMBIA

As the District is already densely populated, any additional population will be accommodated by high density development in some areas, and by neighborhood revitalization and community redevelopment. Approximately 80 percent of the land in the District is developed. Consistent with its role as the Nation's Capital, approximately 45 percent of this developed land is devoted to institutional and other non-residential uses.

Though this reduces the District's taxable base, it has the desirable effect of restricting the amount of land available for potential development and also provides open land in this densely populated area. With residential use comprising approximately 35 percent of the developed land, careful consideration will have to be given to utilizing the undeveloped acres.

The Washington Metropolitan Area Transit Authority has proposed nine routes for movement of commuters by rapid rail as indicated in Figure A-26. Within the District of Columbia, the major portion of the rapid transit system is subsurface level with more than 30 stations. The effect of this rapid rail system on new development has been

From: Metro Information Map

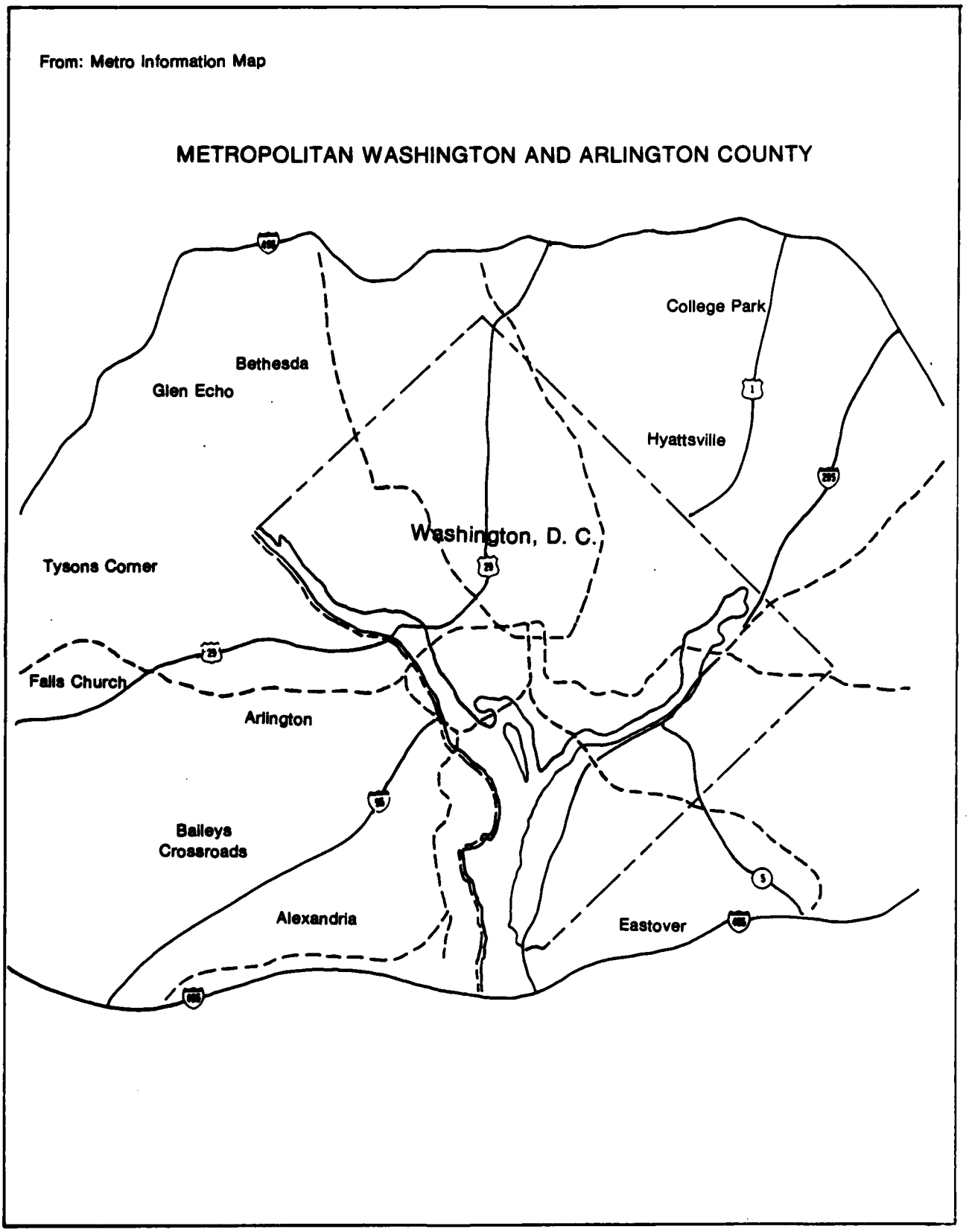


FIGURE A-26

minimal, given the already densely populated nature of the Nation's Capital. But it is conceivable that the effective operation of this system could result in a revitalization of several areas of the District.

The residential real estate market in the District can be generally divided into three areas. The first, which supports the highest land values is situated west of Rock Creek Park. Here, lots of between 1,800 and 7,500 square feet are valued (1978) between $35,000 and $110,000. An exception to this pattern is found in currently prestigious Georgetown, where 2,000-3,000 square foot townhouse lots are valued from $60,000. In the center of the District, which spans from east of Rock Creek Park to the Anacostia River, there are tremendous variations in value.

These are normally linked to neighborhood prestige and usage, though most of the middle market prices are found here. North of the Soldier's Home and Catholic University, lots averaging 1,800 to 7,500 square feet have values ranging between $10,000 and $25,000. It is difficult to generalize about real estate values south of this area. East of the Anacostia River, the most modest real estate values are found. This section of the District has lots of similar size with values between $5,000 and $15,000. An important factor to note is that the energy crisis has had the overall effect of encouraging in-migration to the District. As a result, some of the less desirable neighborhoods are being renovated by urban homesteaders and are becoming more attractive, particularly for those without families. Industrial and commercial lands throughout the MWA are normally valued by the square foot. In the District, industrial land is valued at $5 to $10 per square foot while commercial real estate is valued from $5 to $60 per square foot.

ARLINGTON COUNTY

Located southwest of the District of Columbia and across the Potomac River, Arlington County has developed as an extension of the District. With more than 75 percent of the area in the County already developed, relatively little space is available for additional capacity. Over 30 percent of this developed land is attributable to institutional, commercial, and other non-residential uses such as Arlington National Cemetery, Washington National Airport, and the Pentagon complex. Residential use of developed land, approximating 45 percent, is expected to decrease in the future with a shift toward multi-family dwellings and institutional and commercial influences. Recently constructed high-rise developments are evidence of the County space limitations and indicate an increase in high density development.

The impact of the rapid rail system on Arlington County will probably be similar to the system's impact on the District. One route is operating from National Airport through Rosslyn and then to the District. Another route is in operation with stations at Ballston, Virginia Square, and Clarendon. This is indicated in Figure A-26. In total, 11 stations are located in Arlington County, but because of the highly developed nature of the area, it is anticipated that little new development will occur as a result of the METRO rapid rail system.

Generally speaking, the most expensive properties are located in the northeast quadrant of the County with some of the most expensive residential properties found along the waterfront. The remaining quadrants decrease in value from the northwest and the southeast to the southwest. Lots of approximately one-quarter acre generally range

from $25,000 to $60,000. A typical residential lot is valued (1978) at approximately $3.50 per square foot. Industrial land can be purchased for $5 to $10 per square foot, and commercial land sells for $5 to $40 per square foot.

FAIRFAX COUNTY

With the majority of the present population residing in urban areas, most of Fairfax County is not highly developed. The portion of Fairfax County east of Route 123 and Difficult Run is largely developed, while the western area, with major centers at Reston and Herndon, is less extensively developed. Bordering on the urban centers of Falls Church and Alexandria, Planning Area I, shown on Figure A-27 to include Baileys, Annandale, Jefferson, and Lincolnia, is the most densely populated and developed portion of the County. This area contains approximately 30 percent of the County population, but because the area is near capacity, it is one of the slower growth areas with future development being infill in nature.

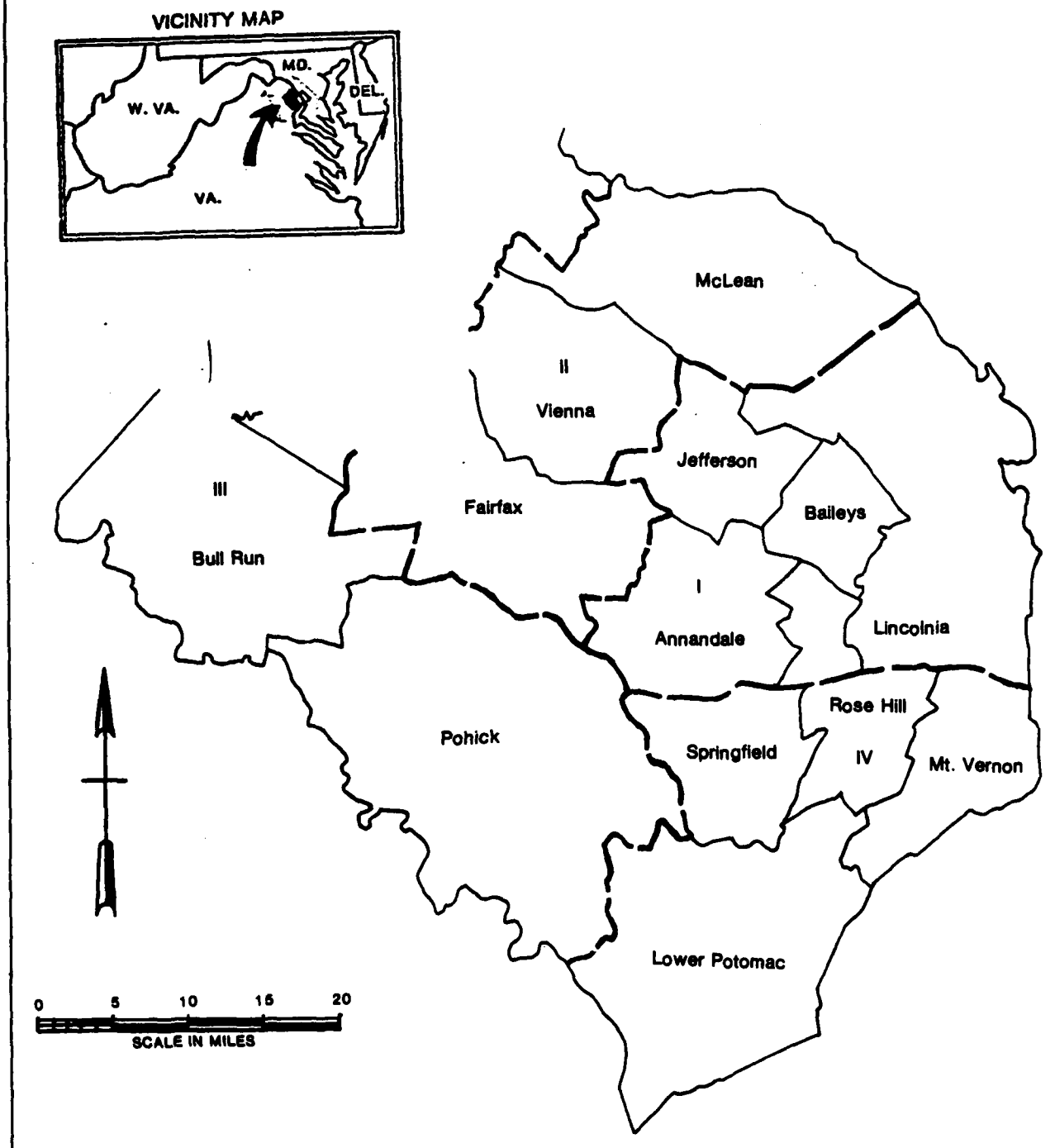
The McLean, Vienna, and Fairfax portion, indicated in Figure A-27 as Planning Area II, is populated with high density development existing near Tyson's Corner, Fairfax Circle, and along Route 123 north of Fairfax City. Land along Difficult Run and the Potomac River will be kept at low density development due to this land's environmental sensitivity. Stable areas are planned to experience residential infill while several areas will become exposed to high density development pressures, especially near the METRO stations at Falls Church, Dunn Loring, and Vienna.

Presently an area of peaceful, rolling farmland, Planning Area III, is possibly the most susceptible to increasing development pressures. While containing approximately 20 percent of the population, this area contains over 60 percent of the total land area, less than half of which is developed. Several planned development centers are proposed in this area with regional-size centers at Reston, Herndon, and Centerville. Smaller village-size centers of development are planned at Burke, Chantilly, and Lower Pohick with low density development planned for areas near Great Falls, Difficult Run, and Western Pohick because of the area's environmental sensitivity. The location of Dulles International Airport and its major access route in Planning Area III are additional factors that will influence development in this portion of the County.

With the exception of a few growing areas, the major portion of Planning Area IV is no longer experiencing a rush to development. Because much of the undeveloped land is affected by floodplains, groundwater recharge areas, and wetlands, little density can be accommodated here. The main emphasis in this area is now on redevelopment with the METRO rapid rail stations at Huntington, Franconia, and Van Dorn subject to potential development pressure.

The overall scheme of residential values (1978) for land in the County shows a decrease in values as the distance from the District increases. The highest priced land is in the northeast along the waterfront and sells for $100,000 to $125,000 per acre. Away from the waterfront in communities near the Potomac such as McLean, quarter-acre lots range in value from $30,000 to $35,000, half-acre lots from $35,000 to $45,000 and acre lots from $65,000 to $85,000. In the northwest, communities like Great Falls have lots of quarter-acre size selling for $20,000 to $25,000, half-acre lots selling for $25,000 to $30,000 and acre lots selling for $35,000 to $45,000. Eastern portions of the County are in the high middle range with cities such as Falls Church and Alexandria being densely

FAIRFAX COUNTY PLANNING AREAS AND DISTRICTS



Source: Fairfax County Comprehensive Plan, 1975

FIGURE A-27

developed. Lots from one-quarter acre to two acres range in value from $20,000 to $22,000 for half-acre parcels, $22,000 to $30,000 for 1 or 2 acre parcels, and $25,000 to $40,000 for 5 acre parcels. Large parcels may sell for as little as $2,000 per acre. The lower values are attributed to the lack of available sewerage, and the poor soil percolation in these areas which prohibits the use of septic systems. Industrial lots in Fairfax County sell for $2 to $10 per square foot while commercial lots are valued form $3 to $25 per square foot.

Fairfax County has approximately ten percent of its land under public jurisdiction. The largest two areas of public land are Ft. Belvoir in the southeast part of the County and Dulles International Airport in the west. The airport does not significantly affect the market in the west; Ft. Belvoir, however, encourages a strong rental market because of the transient nature of the military population assigned to the installation.

PRINCE WILLIAM COUNTY

One of the fastest growing counties in the MWA in the 1960's and 1970's, Prince William, presented in Figure A-28 is expected to continue its development. Growth is presently situated in two major areas: the eastern end of the County, and the north central area around the Cities of Manassas and Manassas Park. The southern portion of the County is relatively undeveloped with the majority of the land occupied by the Quantico Marine Base and the Prince William Forest Park.

Development in the County has moved in two directions: to the east from the Manassas-Manassas Park area and westward from the Interstate 95 corridor. With Interstate 95 a major impetus, the main concentration of development is currently in eastern Prince William County. Growth in the eastern portion can be expected to continue in the already populated areas of Occoquan, Woodbridge, Dale City, and Dumfries. Plans exist to develop a Residential Planned Community at Dale City in addition to the current development at Montclair Country Club Lake. Growth is also anticipated for the Upper Powells Creek area. Because pressure for rural subdivision is increasing, local government facilities may relocate in the area. Plans also exist for extension of sewer lines into the area.

Relatively little development has occurred in the northern portion of the County, but as the County develops, no doubt, some of this activity will extend northward. A potential development stimulus that should be recognized is the extension of Interstate Route 66 from Gainesville to Front Royal. This could result in a westward push of development from the Manassas area of the County.

Not surprisingly, land values tend to decrease with greater distances from the interstate highway corridors of I-66 and I-95. The highest land values are normally found at the interstate interchanges closest to the northern boundary of the County. Lots in Manassas, for example, which range from one-quarter acre to one acre in size are valued at $10,000 to $20,000. In addition, some waterfront lands bring high prices. Other parts of the County contain much agricultural land which is valued at approximately $3,000 per acre, and unimproved land not suitable for farming may sell at $1,000 per acre or less. Both industrial and commercial lands range in value from $1 to $10 per square foot. There are no sewer or water moratoria to restrain construction in the County.

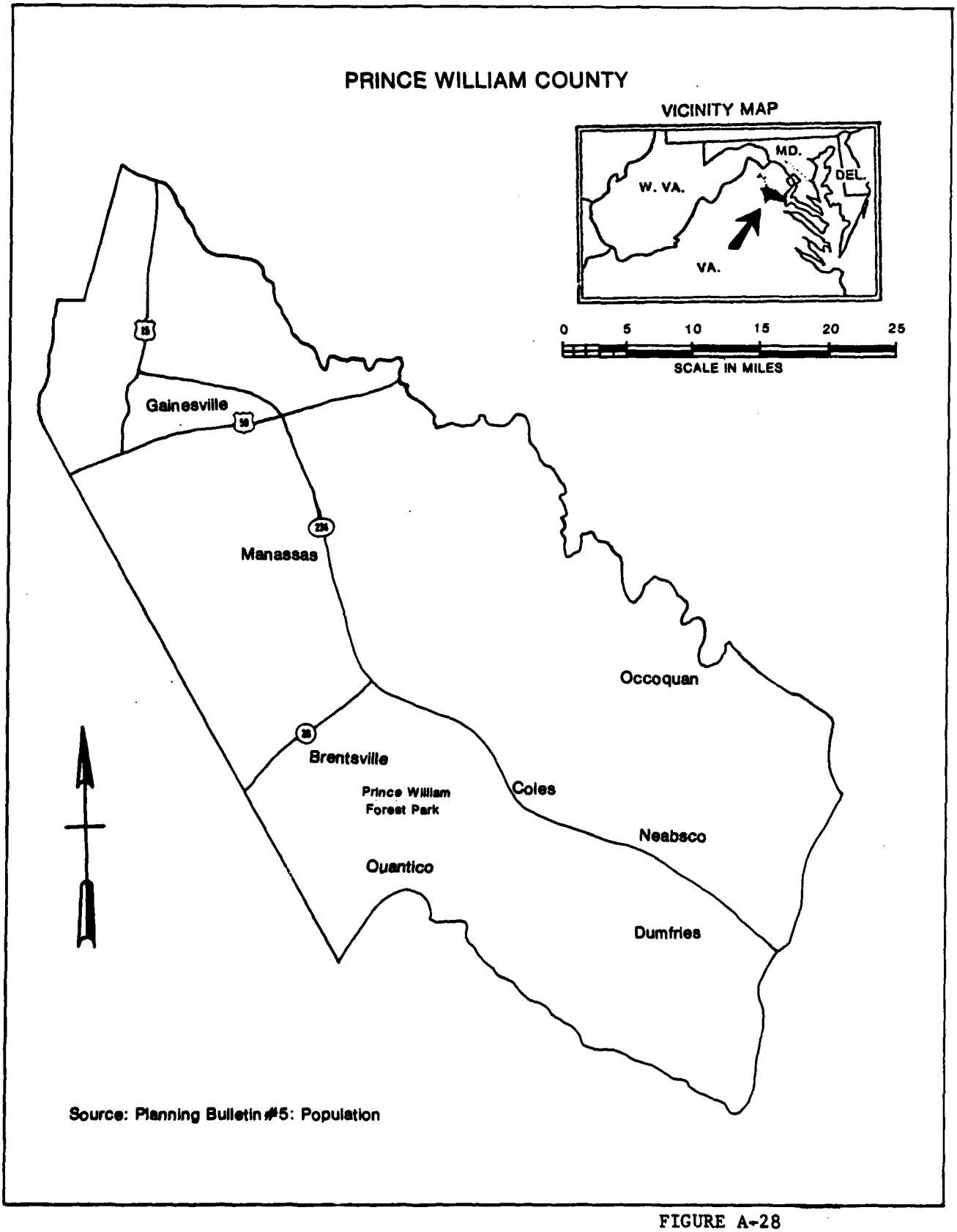

PRINCE WILLIAM COUNTY
VICINITY MAP
MD.
DEL.
W. VA.
VA.
0 5 10 15 20 25
SCALE IN MILES
Gainesville
Manassas
Occoquan
Brentsville
Prince William
Forest Park
Coles
Neabsco
Quantico
Dumfries
Source: Planning Bulletin #5: Population

FIGURE A-28

LOUDOUN COUNTY

Presented in Figure A-29, Loudoun County is the most rural of the MWA counties, with less than ten percent of its land area developed. Though several existing highway corridors connect County population centers to the District, much of the County lies beyond the currently acceptable commuting distance for most people. The majority of the development is located east of Goose Creek in the area known as Broad Run. Since 1970, 75 percent of the County's development has occurred in Sugarland Run, Sterling Park, and Leesburg. To the west of Goose Creek the land is rural or undeveloped with the several incorporated towns accounting for the sparse development in this portion of the County. Leesburg, the center of the local government, is presently the most developed of the incorporated towns.

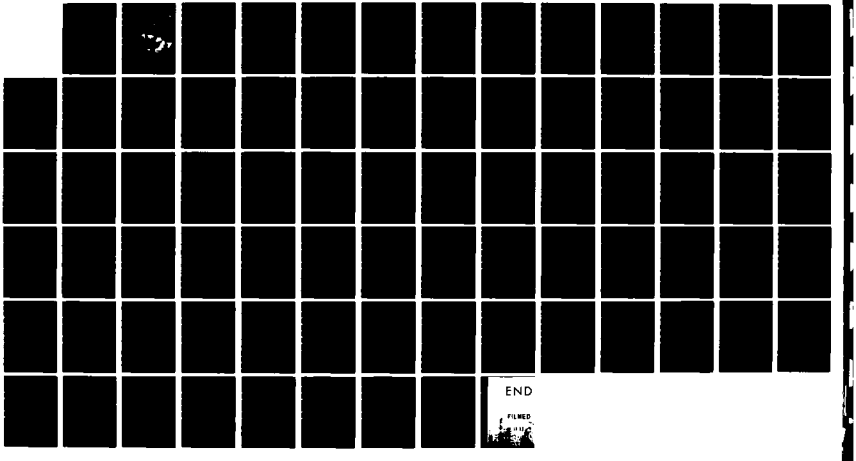
While the County will maintain its predominantly rural nature, additional development will nevertheless occur. Most of this increased development will occur east of Goose Creek in the Broad Run area. The planned communities of Sugarland Run and Sterling Park will continue to attract new development because of the availability of public facilities, the influence of Dulles International Airport on the labor force, and expected development pressure from the Herndon/Reston area of Fairfax County.

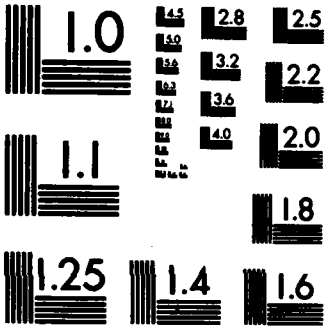
The Town of Leesburg will experience additional development because of its accessibility, its proximity to the major growth center of the County, and its role as the center of local government. Except for small scale development around the towns, the western portion of Loudoun County will maintain its rural undeveloped appearance.

The real estate market is influenced by two major interests. First, an intense agricultural preservation program is in effect which indicates a strong conservation tendency. Secondly, the County supports a market of second homes for those residing in other counties closer to the District or in the District itself.

In general, the real estate market is not high pressured in Loudoun County. Owners are generally not hard-pressed to sell lands for development and in many cases lands are simply not for sale. Throughout the County, market values (1978) per acre tend to be lower for the many large tracts of land. Therefore, a parcel of more than 100 acres may sell for less than $1,600 per acre and a small purchase of 3 or 4 acres may sell for $5,000 per acre. Most residential lots are 10-12 acres and have a fair market value of about $3,000 per acre. Exceptions to this pattern are found in the western portion of the County near the Blue Ridge Mountains, in the northern portion of the County along the Potomac, on the eastern border of the County and in the towns of Middleburg and Leesburg. With the exception of Leesburg, these areas have a recreational character or possess great potential for development. Prices may be given over $5,000 per acre even for large tracts. Leesburg residential lots are generally one-quarter acre in size and sell for approximately $20,000. Industrial land sells for $1 to $10 per square foot while commercial land goes for $2 to $25 per square foot. The County does not have extensive water and sewer facilities and one of its most intensively developed areas, Leesburg, was subject to a water and sewer moratorium. However, with the construction of a Potomac River intake and water filtration plant, Leesburg now has the capability of not only providing water for its own use but also for the use of others. The amount of public land is insignificant and does not appreciably affect the market.

AD-A134 153 METRPOOLITAN WASHNNGTONAAREA WATER SUPPLY STDYY 2/2
APPENDIX A BACKGROUND INF..(U) CORPS OF ENGINEERS
BALTIMORE MD BALTIMORE DISTRICT SEP 83 MWA-83-P-APP-A
UNCLASSIFIED F/G 5/1 NL





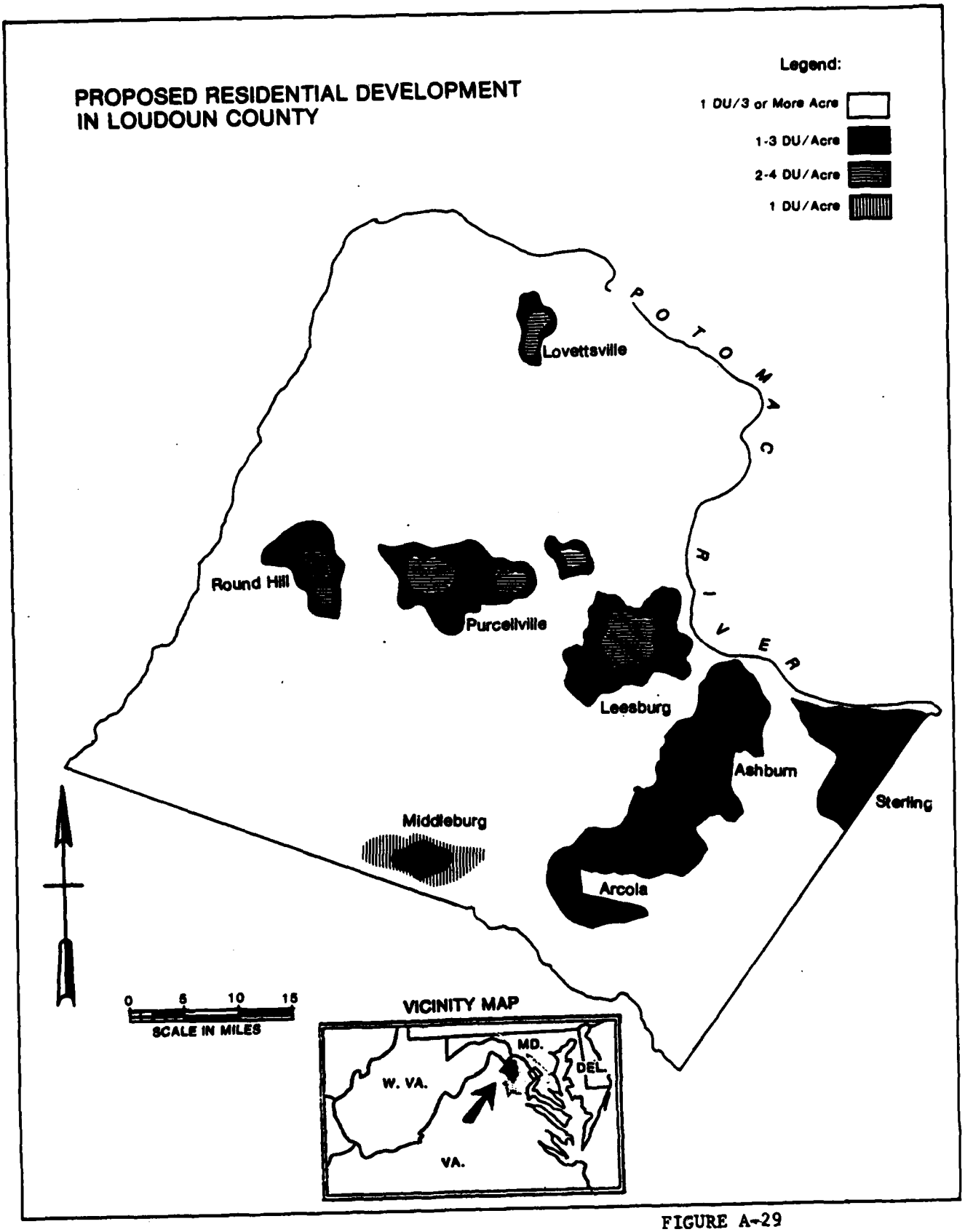

PROPOSED RESIDENTIAL DEVELOPMENT
IN LOUDOUN COUNTY
Legend:
1 DU/3 or More Acre
1-3 DU/Acre
2-4 DU/Acre
1 DU/Acre
POTOMAC RIVER
Lovettsville
Round Hill
Purcellville
Leesburg
Ashburn
Sterling
Middleburg
Arcola
0 5 10 15
SCALE IN MILES
VICINITY MAP
MD.
DEL.
W. VA.
VA.

FIGURE A-29

SUMMARY

Based on the continuing inflationary trend in the MWA, real estate values are likely to increase significantly during the next few years. Values of residential and commercial real estate in desirable areas that are accessible to job centers should continue to inflate. Land development is likely to accelerate as water and sewer moratoria are lifted. As a rough estimate, it is expected that real estate values will continue to inflate at a rate of 10 percent per annum, barring any unusual fluctuations in the state of the economy.

In extremely urbanized areas like the District, Arlington County, Virginia, and portions of Prince Georges County, Maryland, it is expected that redevelopment will assume a larger and larger share of the real estate market. When an area is so much in demand that redevelopment is preferable to developing lands farther away from the business center, real estate values of land rise in a way that is not predictable. Public lands which may be declared excess by the Government may yield important development potential. In addition, near lands acquired for the METRO system, great pressures are expected to intensively develop the real estate. Arlington County, for example, will have 11 metro stops in a small area, and will probably witness further urbanization there unless a strong resistance develops. Furthermore, Prince Georges County is interested in raising its appeal to upper middle class residents. The County government may furnish significant assistance to encourage high quality manor homes in certain sections of the County.

Fairfax County, Virginia, and Montgomery County, Maryland, share a similar potential for continued development since they both have a sizable amount of undeveloped land within reasonable commuting distance of the District.

The outermost counties of Loudoun County and Prince William County, Virginia, and Charles County, Maryland, will probably experience an inflation in real estate values which is more modest. Loudoun County and Charles County are generally less accessible to the District and encourage more conservative development programs. Unless these programs are strongly challenged and commuting times are improved by transportation innovations, the real estate market values should increase at a gradual rate in the next few years. A possible exception to this may occur near Dulles International Airport in Loudoun County where there has been some interest expressed in development. Development may also begin to occur between Waldorf and Mason Spring in Charles County where sewerage facilities have been constructed.

INSTITUTIONAL ANALYSIS

Governmental planning in the Potomac River Basin is conducted by three levels of government (Federal, State, and local) with three branches within each level (legislative, executive and judicial). This three by three matrix of planning cells has varied in its effectiveness in both planning and managing the water resources of the basin. The effectiveness of the planning has generally been a function of the complexity and geographical extent of the problem. Where problems have extended beyond the boundaries of traditional units of state and local government there have been some past problems with effecting a solution. As will be discussed in detail later in this section, more recent coordination activities have been very effective in solving the regional water supply problems of the MWA.

From an institutional perspective the location of the Nation's Capital within the Potomac Basin has had a significant impact on the scope and level of water resources planning in the region. The concentrated Federal interest associated with the National Capital has further complicated the normal problems of coordination already found in a multijurisdictional region. The following paragraphs address the various governmental levels of responsibility within the MWA.

EXISTING FEDERAL WATER RESOURCES INSTITUTIONS

The concept of Federal responsibility for comprehensive development of the water and related land resources is embodied in legislative enactments under the Commerce and Welfare Clauses of the Constitution, as well as with the gradual growth of a body of policy by repeated authorization of specific types of projects. The fundamental objective of the Congress in authorizing Federal participation in resource development has been to insure that the Nation's resources make an optimum contribution to the health and welfare of its people. At the same time, the Congress seeks to maintain a reasonable balance between the powers assumed by the Federal government and those to be left with the states, local governmental entities, and private enterprise.

The Water Resources Planning Act of 1965 officially identified this as National policy and emphasized local state-Federal cooperation:

> In order to meet the rapidly expanding demands for water throughout the Nation, it is declared to be the policy of the Congress to encourage the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by the Federal government, states, localities and private enterprise, with the cooperation of all affected Federal agencies, states, local governments, individuals, corporations, business enterprises, and others concerned (U.S. Code, Title 42, Sec. 1962).

Continued efforts are still being undertaken through legislation for the cooperative approach to water resources planning. Table A-22 presents those institutions that are involved in that effort on a National scale. As can be noted from Table A-22, there are basically three ways in which the Federal government contributes to projects of regional or local benefit: directly, indirectly, and financially. Direct participation involves research, planning, preparation, operation and maintenance (or any combination of these) of one or more elements of a project by the Federal government itself. Indirect aid

TABLE A-22

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Committee On Appropriations		X							Appropriations for water supply, agency research and development, grants and loans (e.g., Corps of Engineers) Appropriations for the District of Columbia, it also handles matters as the Temporary Commission on Financial Oversight of the District of Columbia.
	- Subcommittee on Public Works		X							
	- Subcommittee on the District of Columbia		X							
	Committee on Environment and Public Works	X	X				X			Environmental policy. Environmental research and development. Ocean dumping. Fisheries and wildlife. Environmental aspects of Outer Continental shelf lands. Solid waste disposal and recycling. Environmental affects of toxic substances, other than pesticides. Water resources. Flood control and improvements of rivers and harbors including environmental aspects of deepwater ports. Public works, bridges and dams.
	- Subcommittee on Water Resources	X	X				X			

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
HOUSE OF REPRESENTATIVES	Committee on Governmental Affairs	X		X	X	X	X	X	X	Municipal affairs of the District of Columbia except appropriations. Study or investigation of intergovernmental relationships between the U.S. and the states and municipalities, including the Federal government and state and local governments and the manner in which Federal assistance is disbursed to state and local governments.
	- Subcommittee on Intergovernmental Relations	X	X	X	X	X	X	X	X	
	Committee on the Judiciary	X	X				X	X	X	Interstate compacts.
	Committee on Agriculture									Soil and water conservation, small watershed program, agricultural credit generally.
	- Subcommittee on Conservation and Credit	X					X		X	

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Committee on Appropriations		X							Appropriations for water supply, agency R&D grants and loans. Appropriations for the District of Columbia. Appropriations for Corps of Engineers Civil, Interstate Commission on the Potomac River Basin; Susquehanna River Basin and Delaware River Basin Commissions, as well as the Water Resources Council.
	- Subcommittee on the District of Columbia		X							
	- Subcommittee on Public Works		X							
	Committee on the District of Columbia	X		X	X	X	X	X	X	All measures relating to the municipal affairs of the District of Columbia other than appropriations including - public health, water supply, taxes, Municipal code amendments, etc. Legislation on home rule, bond authority and fiscal affairs. All proposed legislation, messages, related to public utilities; review of the environmental aspects of the Potomac River, and the water and sewer systems of the District.
	- Subcommittee on Fiscal and Government Affairs	X	X							
	- Subcommittee on Economic Development and Regional Affairs	X		X	X	X	X	X	X	

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Committee on Government Operations	X	X						X	Intergovernmental relationships between the U.S. and the states and municipalities and general revenue sharing. Corps of Engineers activities are reviewed by the group as they pertain to D.C. Compacts relating to the use and apportionment of interstate waters. Water rights. Water resources planning conducted pursuant to the Water Resources Planning Act. Programs involving major interbasin movement of water or power.
	- Subcommittee on Environment, Energy and Natural Resources	X							X	
	- Subcommittee on Water and Power Resources	X					X		X	
	Committee on the Judiciary	X								Interstate compacts and their legality.
	Committee on Public Works and Transportation	X								The Crops of Engineers Water Resources Program is reviewed by this group.
	- Subcommittee on Water Resources	X		X	X	X	X	X	X	

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
Organic Act. Ch. 12 Stat. 387. 15 May, 1862	Dept. of Agriculture - Agricultural Research Serv.	X								Conducts research to provide a scientific basis and support for the land and water resource programs.
Consolidated Farmers Home Administration Act of 1961 (7 USC 1921)	- Soil Conservation Service	X	X	X	X	X	X	X	X	Assistance to localities for small watershed planning leading to works of improvement (structural and non-structural). Provides grants up to 50 percent of costs of state or local units to acquire land, access rights, or facilities for recreation, conservation or flood protection in small watersheds (less than 250,000 acres and non-navigable). Watershed Protection & Flood Prevention Act of 1954 (P.L. 83-566; 16 USCA 10001).

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
Public Works and Economic Development Act of 1965 (P.L. 89-136) 42 USCA 3121 et. seq.	Department of Commerce - Economic Development Adminis.		X							Secretary is authorized to make direct grants or loans for the acquisition or development of land and improvements for public works. Grants for up to 50 percent project costs.
Rivers and Harbors Act of 1899 and Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500; 33 USCA 1251 et. seq)	Dept. of Defense - Dept. of the Army	X	X	X	X	X	X	X	X	Permits are required for all proposed dredging and filling operations in the navigable waters of the US, including wetlands landward at least to the extent of mean high water. Corps of Engineers Water Resources Development Programs include structural and non-structural elements, such as: 1) improvement of harbors and navigable channels (33 USCA 540). 2) engineering reports on streams, shores and flood plains (33 USCA 426). 3) flood control and related works for water supply (33 USCA 708).

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
Housing and Community Development Act (P.L. 93-383)	Dept. of Housing and Urban Development	X	X						X	Provides funding for states and general purpose local governments for acquisition and disposition of real property; construction of certain public facilities: water and sewer lines, etc.
Act of March 3, 1879; 20 Stat. 394; 43 USC 31	Dept. of the Interior - U.S. Geological Survey	X								The evaluation of available waters in river basins and groundwater provinces.
Act of June 22, 1870; 16 Stat. 162; 28 USC 501	Dept. of Justice - Land and Natural Resources Division	X								Water rights and the protection of water resources are determined by this division.
Water Resources Planning Act of 1965 (P.L. 89-80 Title III)	Water Resources Council	X	X						X	Financial aid to states for promotion of comprehensive Water and Land Resource Planning under Title III. Grants based on population, land area, financial needs and need for comprehensive water resources planning.

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
Environmental Education Act (P.L. 91-516)	Dept. of Health Education & Welfare		X							Project grants to assist state, local and other public, private, non-profit educational agencies, organizations or institutions in developing environmental education projects and curricula development. Applicants must assume at least 20% of the cost of the first year project, 40% in the second year, and 60% in the third year.
Reorganization Plan No. 3 and FWPCAA of 1972 (P.L. 92-500)	Environmental Protection Agency		X							Provides grants to area-wide planning agency for preparation of plan in areas which, as a result of urban industrial concentration, have water quality control problems.
Federal Property and Administration Services Act of 1949	General Services Administration	X								An assessment of water use in the Federal government develops policy from among other duties.

TABLE A-22
(Cont'd)

FEDERAL INSTITUTIONAL MANAGEMENT - THE CONGRESSIONAL COMMITTEES AND FEDERAL AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
40 USC 71	National Capital Planning Commission	X								It plans the appropriate and orderly development and redevelopment of the National Capital and the conservation of the important natural and historical features.

SOURCE: The Washington Monitor, Congressional Yellow Book, The Washington Monitor, Inc., Washington, D.C. (August, 1978).

includes services of information, advice and assistance for activities of other levels of government in research, planning, engineering, and technical areas, as well as use of Federal facilities. Financial aid is usually in the form of direct grants, perhaps tied to specific purposes; loans, repayable or nonrepayable, advances, and purchase or underwriting of bond issues.

Grants may be for specific projects, or they may be formula grants, in which the size of the grant depends by formula on certain criteria: population, income and geographical area. In general, there is a matching requirement to be met by the recipient. Direct loans may be made at zero or less-than-market interest rates, or if at market rates, in an amount greater than would ordinarily be available. Non-interest bearing advances are usually repayable, but may be made nonrepayable if certain conditions are met. A bond issue of a state, local, or non-governmental agency may be guaranteed or purchased outright, or a loan made to such an agency might be guaranteed or insured. Detailed informaton concerning the specific programs of these agencies may be found in the Office of Management and Budget's Catalog of Federal Domestic Assistance, Government Printing Office, Washington, D.C. (1978).

INTERSTATE AND BASIN INTERESTS IN WATER RESOURCES

In the MWA there are two institutions which function on an interstate level - the Interstate Commission on the Potomac River Basin and the Metropolitan Washington Council of Governments.

INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN (ICPRB)

In 1940, the Congress authorized Maryland, Virginia, Pennsylvania, West Virginia and the District of Columbia to enter into a compact providing for the creation of a conservancy district in the Potomac River Basin for "...the purpose of regulating, controlling, preventing, or otherwise rendering unobjectionable and harmless the pollution of the waters of said Potomac drainage area by sewage and industrial and other wastes." (Public Resolution No. 93, 76th Congress, 54 Stat 748; 1940.) Recent Congressional action in 1970 completed what was at least a six-year effort to revise the ICPRB compact. These amendments broadened the authority of ICPRB:

1) to include water resources and associated land resources, 2) to allow ICPRB to cooperate with and assist public and non-public agencies in planning related to water resources and associated land resources, and 3) to provide for the establishment of sections consisting of the Commissioners interested in problems which affect two or more, but not all, of the signatories (Article III of the Compact). Basically, these powers are advisory.

The ICPRB consists of three members from each of the four states and the District of Columbia, and three members are appointed by the President. Each member provides for selection of its representatives; for example, Virginia law requires appointment by the Governor with one member required to be a resident of the Basin, one a member of the Virginia Commission on Interstate Cooperation, and the other to be appointed at large.

The Commission is financed by appropriations from the signatories and the United States. These appropriations vary depending upon the financial status of each of the signatories, as well as the number of projects under study by the Commission that benefit the signatory. The compact allows a signatory to withdraw after one year's notice.

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS (MWCOG)

The MWCOG became incorporated as a non-profit organization in 1965. Sixteen major local governments - the District of Columbia, two major Maryland and four Virginia counties, and nine cities - are represented on the MWCOG. The general membership includes all elected officials of the counties and cities (220); the District of Columbia mayor, deputy mayor, and the city councilmen; Maryland and Virginia state legislators and congressmen who represent districts in their states that fall within MWCOG's jurisdiction; and all the members of the District committees of both houses of Congress, until such time as the District of Columbia is given Congressional representation.

The Council is empowered to advise and assist local governments of the region to: 1) identify mutual problems, 2) develop and promote a comprehensive regional plan, 3) seek mutually desirable policies and develop cooperative mechanisms among local governments, 4) support and promote concerted action among the local governments, and 5) serve at the request of local governments as their representative on regional matters. The Council does not have authority to legislate, regulate, enforce or tax; and member governments can oppose any proposal or withdraw form MWCOG whenever they choose. The fact that a representative from a given community votes in favor of a proposed council action in no way obligates his or her community to follow his or her lead. MWCOG is limited by its charter to advising and assisting local governments of the region on areawide matters. Although the charter does give it authority to represent local governments on matters of regional concern upon their request, this authority has not been interpreted broadly enough to permit MWCOG to engage in the direct operation of regional facilities. As a result, MWCOG is not in a position to take advantage of certain economies of scale through regionalization, although it can and does encourage such economies through its comprehensive planning and advisory roles. Table A-23 summarizes the basic functions of these two regional agencies.

STATE WATER RESOURCES DEVELOPMENT

STATE OF MARYLAND

State Laws

The right to use water in Maryland is developed through court decisions as part of the Common Law of the State. In essence, Maryland is recognized as owning the Potomac River bottom to the low water line on the Virginia side of the river. Although Maryland ceded to the Congress of the United States a district of ten miles square to be used for the seat of the Federal government, the transfer of ownership and the latter consent given to the appropriation of surface waters for water supply to the City of Washington did not relinquish Maryland's sovereignty over the waters. Instead, the Federal entity is considered by Maryland as a lower riparian user.

Maryland's appropriation permit program is a system by which Maryland's sovereign prerogatives over water withdrawals within its territorial boundaries are recognized and assessed. Under this system, Maryland's authority over Potomac River withdrawals under

TABLE A-23

INSTITUTIONAL MANAGEMENT ON AN INTERSTATE SCALE

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
ICPRB Compact P.L. 91-407 (Sep. 1970)	INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN	X						X	X	see text preceeding table.
	Metropolitan Washington Council of Governments	X							X	see text preceeding table.

a "riparian" permit system is not to allow it to deprive the District of Columbia, or any lower riparian, of a reasonable use of river waters. Maryland, therefore, is to insure that water is available to the competing interests within the framework of Maryland's sovereign authority to regulate the appropriation of Potomac water within its boundaries. To support this assurance, Maryland administrative approval is a necessary prerequisite for the withdrawal of water.

To blend in with the permit process and to make it more functional, in 1972, the General Assembly authorized the Maryland Environmental Service of the Department of Natural Resources to prepare comprehensive 5-year regional or river basin water supply facility plans. Because of this, the State is now able to correct limitations or deficiencies in local or regional plans. Table A-24 depicts the legislative interests in the State which govern over the water resources of Maryland.

State Agencies

The following discussion focuses only on those state departments and entities with major responsibilities for water and related land resources planning, development and management. These departments include Natural Resources and Health and Mental Hygiene. Another entity is the Maryland Potomac Water Authority.

Department of Natural Resources

The Department of Natural Resources (DNR) was created as the principal natural resources management agency, effective July 1, 1969 (Natural Resources Article, Annotated Code of Maryland, 1974 Replacement Volume). It was the intent of the Maryland General Assembly, in providing for the DNR, to establish a state agency to review all natural resources policies, plans, programs, and practices of the state, county, regional and Federal agencies and institutions; to coordinate all natural resources activities within the state; and to unify, coordinate, and promulgate policies, plans, programs and practices which would insure the management of all natural resources for the greatest benefit of the state.

The head of the DNR is the Secretary of Natural Resources, who is appointed by the Governor with the advice and consent of the Senate. The Secretary serves at the pleasure of the Governor, is directly responsible to the Governor, and advises him on all matters assigned to the DNR. The Secretary is responsible for carrying out the Governor's policies in the areas of natural resources research and development, management and administration.

The central administration in the DNR dealing with water supply is the Water Resources Administration. It was the intention of the General Assembly in establishing this Administration to exercise to the fullest extent possible the responsibilities of the State of Maryland for the planning, development, and management of the state's water resources.

The Director of the Water Resources Administration (WRA) is appointed by the Governor upon the recommendation of the Secretary of the DNR. He is to be responsible for the exercise of all the powers and duties conferred upon the Administration in the provisions of Title 8 of the Natural Resources Article. The powers and duties of the Administration include:

TABLE A-24

INSTITUTIONAL MANAGEMENT STATE OF MARYLAND LEGISLATIVE COMMITTEES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
SENATE	Committee on Judicial Proceedings	X				X				Handles the responsibility of changes in existing legislation having to do with water supply management.
	Committee on Finance		X							Appropriates money for water supply management budgets for State agencies.
GENERAL ASSEMBLY	Committee on Appropriations		X							Appropriates money for water supply management budgets for State agencies.
	Committee on Environmental Matters	X				X				Policy making for water supply.
	Committee on the Judiciary	X				X				Handles the responsibility of changes in existing legislation on water supply matters.

1) preparing and developing a general water resources program which contemplates the proper development and management of the waters of the state on a multiple-purpose basis;

2) making surveys, maps, investigations and studies of the water resources of the state;

3) controlling, through the issuance of permits, the appropriation and use of the surface and underground water of the state (except for agricultural use);

4) construction, reconstruction and repair of dams, reservoirs or waterway obstructions;

5) administration of financial assistance as may be made available by the state to contribute up to 50% of the non-Federal share of approved P.L. 83-566 projects;

6) permits for conduits, pipes, etc. pertaining to the Potomac River;

7) development and carrying out of long-range programs for flood control in cooperation with the Federal agencies;

8) pollution control - activities including erosion and sediment control, oil spill control and enforcement, and stormwater management.

Department of Health and Mental Hygiene

The Department exercises responsibility for the general supervision and control over the sanitary condition of the waters of the state as related to public health. This responsibility is carried out by the Department's Office of Environmental Programs.

Several powers and duties of the Department are as follows:

1) supervise and control the waters of the state, insofar as their sanitary and physical condition affect the public health or comfort;

2) investigate all sources of potable water and ice supply and all points of sewage discharge;

3) examine all existing public water supplies, sewage systems, and refuse disposal plants, with power to compel their operation to protect the public health and comfort, and order their alteration, extension or replacement by other structures when deemed necessary;

4) pass upon the design and construction of all public water supplies, sewerage systems, and refuse disposal plants;

5) govern the individual water supply and sewage disposal systems for homes and other establishments in the counties of Maryland where public water supply and sewerage systems are not available;

6) promote the construction of water, sewerage, and solid waste facilities with the use of Federal and state funds;

7) consult with and advise county and municipal authorities and others on water supply and waste disposal problems;

8) encourage basin-wide plans leading to the integration of communities to be served by single treatment facilities where possible.

9) regulate well drilling through the licensing of well drillers, and issuance of permits to drill wells.

Maryland Potomac Water Authority

In 1969, the General Assembly created the Maryland Potomac Water Authority to conserve, control, and put to beneficial use the storm and flood waters of the rivers and streams of the Potomac River watersheds in Allegany, Frederick, Garrett, Montgomery, Prince Georges and Washington Counties (Maryland Annotated Code, Article 96, Sec. 8-104).

The Authority is presently comprised of ten members: a Chairman appointed by the Governor, county commissioners or councilmen from the six Maryland counties located along the non-tidal portion of the Potomac River, and the Washington Suburban Sanitary Commission, the Department of Natural Resources, and the Department of State Planning. The Authority originally contracted with the Federal government for acquiring initial storage in the Bloomington Lake project; however, based on actions taken in July 1982 that original contract has been terminated and the Bloomington water supply storage has been purchased by the MWA utilities. Table A-25 summarizes the institutional information for the aforementioned State of Maryland agencies.

COMMONWEALTH OF VIRGINIA

Water Laws of the Commonwealth

Virginia follows the reasonable use formulation of riparian law with respect to water in natural streams. The reasonable use doctrine holds that the riparian owner is protected in his use of the waters of the stream so long as that use is reasonable in relation both to the available flow in the stream and to the use made of the stream by other riparian owners. The Virginia courts have, over the years, evolved a doctrine which gives high priority to domestic uses, which are defined as uses to serve household needs, watering of livestock, and irrigation of the household gardens. This priority is so strong that a particular riparian owner is permitted to exhaust the flow of a stream in order to serve his domestic needs. Other uses, such as agricultural, industrial, and municipal are subject to the balancing concept of the reasonable use doctrine. Whatever the use, however, the riparian owner does not have a right either to use the water on non-riparian land or to use it on land outside of the watershed of the stream, even though it is part of a parcel of land riparian to the stream.

The Virginia General Assembly has frequenty legislated in the area of water resources, but has always been careful to express its intent that such enactments are not meant to modify common law riparian rights. The principal enactments are the Water Resources Act of 1972, the enactments of delegating various powers to localities, the Groundwater Act of 1973, and the State Water Control Law of 1946.

TABLE A-25

INSTITUTIONAL MANAGEMENT STATE OF MARYLAND STATE AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
Annotated Code of Maryland Art. 1. 1957 Edit. 1969 Cum. Sup.	Department of Natural Resources	X	X				X		X	Reviews all natural resources policies, plans, programs, and practices of state, county, regional and Federal agencies and institutions and coordinates all natural resources activities within the state and insures the management of all natural resources.
Maryland Code, Art. 96 A, 1970 Supp.	Water Resources Administration	X	X		X		X	X	X	Plans for multiple purpose development and management of the waters of the state: surveys and maps: appropriates the use of water: handles construction, reconstruction and repair of dams: handles cost sharing in the Watershed Protection and Flood Prevention Act Projects: grants permits for construction on the Potomac: develops long range programs for flood control.

TABLE A-25
(Cont'd)

INSTITUTIONAL MANAGEMENT STATE OF MARYLAND STATE AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Department of Health and Mental Hygiene	X	X		X	X	X	X	X	Is responsible for the health and safety of the public water supplies of the State.

In essence then, power is basically with the localities - the cities, counties and towns - and only to the extent necessary to enable the localities to engage in the provision of water to their inhabitants. Localities are specifically granted the authority to engage in the business of water supply, and one or more localities may also accomplish this through several types of semi-autonomous bodies - sanitary districts, water authorities, and service districts (Virginia Code Annotated Secs. 21122.22 to 21.118.3, Repl. vol. 1975; Secs. 15.1-1239 to 15.1-1270, Repl. vol. 1973; Secs. 15.1-1420 to 15.1-1441, Repl. vol. 1973). Water supply policies in Virginia therefore, have become quite fragmented.

In all of this however, one item of particular interest is the issue of Virginia's border on the main stem of the Potomac. As a matter of history, this issue was treated by the Compact of March 28, 1785 and the Arbitration Award of January 16, 1877. In consequence, the border of Virginia on the Potomac opposite Maryland is set at the low watermark on the Virginia side. While the Potomac is thus primarily a Maryland river geographically, Virginia's rights in the Potomac continue:

> Virginia is entitled not only to full dominion over the soil to the low water mark on the south shore of the Potomac, but has a right to such use of the river beyond the low-watermark as may be necessary to the full enjoyment of her riparian ownership without impeding the navigation or otherwise interfering with the proper use of it by Maryland, agreeably to the compact of 1785.

This provision is basically a restatement of the common law reasonable use doctrine, and the effect is to preserve the riparian rights of owners of Virginia land riparian to the Potomac opposite Maryland.

Another item of interest is that although Virginia generally is considered to be a water abundant state, disparities in geographic patterns of water availability and population distribution have created water supply shortages, especially in the populous northern and southeastern sections of the state. These shortages have given rise to proposals for major transfers of water from areas of relative surplus to areas of projected deficit.

Considerations of interbasin water transfers give rise to several unresolved institutional issues. The absence of an administrative allocation program for water in Virginia means that no agency has authority to determine the legal status of a proposed diversion. Several Federal, state and local government entities exercise controls over various aspects of such a diversion project, but none of these required approvals constitute final authorization for a transfer. For example, a principal local constraint is the requirement of consent by the political subdivision in which the extra-territorial water supply project is to be located.

The ultimate determination of the legality of interbasin transfer in Virginia must be determined by application of the riparian doctrine. Of primary interest with regard to the validity of interbasin transfer is the requirement of the doctrine that the water be used on riparian land. Since riparian land in the broadest sense does not extend beyond the watershed of the stream in question, interbasin transfers in general are not given legal recognition under the riparian doctrine.

Of final note, Virginia has limited formal mechanisms specifically designed for emergency allocation of water. In the case of streamflow, this situation arises from the lack of allocation controls beyond the riparian doctrine. The Virginia Emergency

Services and Disaster Law of 1973 includes general provisions applicable to resource shortages. The Governor is authorized to declare a local emergency as the result of a resource shortage upon petition of the local governing body when a sufficient threat of disaster exists. Once such a declaration is made, local governing bodies assume special powers to combat the disaster and protect health and safety. A recent enactment authorized restrictive ordinances during water supply emergencies and establishes a procedure for interjurisdictional allocation of water during emergencies in cases where system interconnections already exist. Table A-26 presents the legislative elements of the Commonwealth of Virginia which are responsible for water policies.

Commonwealth Departments and Agencies

The Commonwealth of Virginia is comprised of many agencies which have major and related responsibilities for water supply. These major organizations influencing area water supply and water quality management decisions include the State Water Control Board, the State Department of Health, and the State Corporation Commission.

State Water Control Board

The State Water Control Board (SWCB) was created in 1946 with the enactment of the State Water Control Law (Virginia Acts of Assembly 1946, Chptr. 399) which had pollution control, prevention and abatement as its general goals. The Board was established in the Executive Department for the purpose of exercising general supervision over the administration and enforcement of the law.

The SWCB has general responsibility for the state's water quality program and exercises several specific functions in connection with the administration and enforcement of the State Water Control Law. Areas of responsibility include the establishment of water quality standards; the issuance of certificates to parties causing pollution; adoption of regulations to supplement statutory pollution law and control discharges from boats; establishment of requirements for waste treatment facilities; administration of financial assistance programs; water quality planning; certification of projects req .iring Federal licenses; investigation of fish kills; and abatement of pollution from petroleum discharges. In addition to its responsibilities related to the state's water quality program, the SWCB is responsible for the administration of a water resources program, including policy formulation, comprehensive river basin planning, water resources coordination, designation and administration of critical ground water areas, regulation of dam safety, state coordination of the national flood insurance program, collection of hydrologic data and advisory services.

The present Board consists of seven members appointed by the Governor, subject to confirmation by the General Assembly. The State Water Control Law specifies that members of the Board must be citizens of Virginia selected from the state at large for merit without regard to political affiliation. Persons directly associated with industries or political subdivisions, who are certificate holders under the law cannot serve as members of the Board.

The Board is authorized to elect a chairman from its members and to employ an Executive Secretary to serve as the chief executive officer of the agency. The Executive Secretary exercises such administrative authority as is conferred upon him by the Board. These delegated responsibilities may include all the powers and duties invested in the Board with the exception of the following: the adoption and promulgation

TABLE A-26

INSTITUTIONAL MANAGEMENT COMMONWEALTH OF VIRGINIA LEGISLATIVE COMMITTEES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Committee on Finance		X							Appropriates money for water supply, management, budgets for particular commonwealth agencies.
	Committee on Agriculture	X					X			Provides technical aid in water supply management related programs; deliberating on water supply management policies and programs as they affect agricultural considerations.
	Committee on Conservation and Natural Resources	X					X			Is generally a policy making group responsible for legislation and legislative actions that amend various laws in the Commonwealth.
	Committee on Education and Health	X							X	Coordinates with local units of government in the development of policies and programs where water supply relates.
	Committee on Local Government	X					X			Handles all categories of water supply management from a local perspective. Generally from a policy-making viewpoint.

TABLE A-26
(Cont'd)

INSTITUTIONAL MANAGEMENT COMMONWEALTH OF VIRGINIA LEGISLATIVE COMMITTEES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
HOUSE OF DELEGATES										
	Committee on Justice	X					X			Handles the responsibility of changes in existing legislation having to do with water supply management.
	Committee on Finance		X							Appropriates money for water supply management, budgets for particular State agencies.
	Committee on Counties, Cities and Towns	X					X			Handles all categories of water supply management from a local perspective. Generally from a policy making viewpoint.

TABLE A-26
(Cont'd)

INSTITUTIONAL MANAGEMENT COMMONWEALTH OF VIRGINIA LEGISLATIVE COMMITTEES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Committee on Health, Welfare and Institutions		X						X	Coordinates with local units of government in the development of policies and programs where water supply is related to the health of the Commonwealth.
	Committee on Conservation and Natural Resources	X								Water resources policy making group.
	Committee on Agriculture	X		X		X	X			Provides technical assistance in water supply management related programs.

of standards, rules, and regulations; the revocation of certificates; and the issuance, modification or revocation of orders to waste dischargers, except in emergency situations as defined by law.

The operating budget of the SWCB is met from a combination of state and Federal funds. When certain conditions are met, the Administrator of the Environmental Protection Agency is authorized to allocate funds appropriated for operation of pollution control programs among the states and interstate agencies on the basis of the pollution problem within the respective jurisdictions. The Board also receives funds from the U.S. Water Resources Council, participates in U.S. Geological Survey programs involving funds from the Federal funding, and has been the recipient of funds from the U.S. Department of Housing and Urban Development in connection with the flood insurance program.

State Department of Health

The State Department of Health performs several functions directly related to water resource use and management. Activities included in this category are the control over public water supplies, regulation of sewage disposal, control of seafood sanitation, control over sources of radiation, regulation of disposal of solid wastes and toxic substances, collection of data on toxic substances and mosquito control.

Under the control over supplies of water, the State Board of Health has general supervision and control over all water supplies and waterworks in the state insofar as the sanitary and physical quality of waters furnished for drinking or domestic purposes affect the public health. According to the statutory definition of waterworks, this authority extends to all structures and appliances used in connection with the collection, storage, treatment, and distribution of domestic water to the public, to more than 25 individuals, or to more than 15 residential consumers. The term "water supplies", as used in the above sentence applies to all water contained in such waterworks, but does not include any water above the point of intake. The source of the water supply is subject to Board approval. Therefore, the Board can prohibit the use of stream or other bodies of water as a source of supply even though it apparently has no authority to exercise further control over the water above the point of intake, with the exception of its regulatory powers over sewage disposal.

Waterworks, under the authority of the Board as described above, cannot be established or operated without a written permit from the Board. Such a permit authorizes a particular source or sources of water and the manner of storage or treatment to be employed. Utilization of a different source or supply or any change in the manner of storage or treatment requires an additional permit. The Board may amend a permit or revoke it when necessary for the protection of the public health. Actions of the Board regarding permits can be appealed in the courts.

The Board is empowered to adopt rules and regulations governing waterworks and water supplies. Existing regulations contain requirements for administrative procedures; waterwork design and operation; development of water sources; and design of treatment, pumping, storage, and distribution systems. The principal impact of these regulations on the allocation and use of natural water supplies arises from the provision with regard to source development. When surface sources are utilized, the regulations provide that the quantity be adequate for water demand of the area to be serviced, including a reasonable surplus for anticipated growth, and that sanitary surveys be conducted to determine the

quality of the source and the factors that may have a future effect on quality. Requirements concerning impoundments and intake structures are primarily aimed at the protection of water quality. With regard to ground water sources of supply, restrictions are placed on well location, construction, and development. Provisions are also included with regard to protective measures for preserving the quality of water from underground sources.

After approval of the operation of waterworks, the Board may issue orders to the owners of such systems requiring changes in the supply or facilities to be completed within a prescribed time. In the case of imminent danger to the public health, the Health Commissioner is authorized to issue emergency orders for the immediate cessation of the operation of the works. Emergency orders are effective for a period determined by the Commissioner but cannot exceed 60 days. The right exists for appeal for any party dissatisfied with any order by the Board or Commissioner.

The Board consists of nine members appointed by the Governor for a minimum of four-year terms. Two Board members must be members of the Medical Society of Virginia, one must be a member of the Virginia Pharmaceutical Association, and one a member of the State Dental Association.

State Corporation Commission

The Commission was put into operation by a 1903 enactment of the General Assembly relating to the appointment and organization of the Commission and its jurisdiction, powers, functions, and duties. Two basic responsibilities, relative to water resource use conferred in this fashion, concern the regulation of water supply and sewer companies, and the licensing of dams under the Water Power Development Act.

Under existing law, any water or sewer company proposing to serve more than 50 customers is required to incorporate as a public system. However, this provision does not apply to water and sewer companies incorporated before January 1, 1970. Also excluded are municipal corporations, other political subdivisions, and public institutions owned or controlled by the state.

Statutory provisions state that the Commission shall have the power and be charged with the duty of supervising, regulating and controlling all public service companies doing business in the state, in all matters relating to the performance of their public duties and their charges therefore, and of correcting abuses. The Commission is charged with the duty of conducting an annual review of the rates of all public utilities. If such rates are found to be unjust, unreasonable, insufficient or unjustly discriminatory, the State Corporation Commission has the power to fix or order substituted rates.

Although not all water and sewer companies are regulated as public utilities, those that serve more than 50 customers are subject to special controls under certain conditions. Upon application by a majority of its customers by the company itself, the Commission may hold a hearing and order improvements or rate changes. When such action is taken, the water or sewer system remains subject to the Commission's regulatory authority in the same manner as a public utility for such reasonable period as the Commission directs.

The Commission's most direct water resource responsibility consists of its regulatory powers regarding construction of dams in certain waters of the Commonwealth. Statutory language provides that:

> ...the control and regulation on the part of the State of the development of the waters of the State shall be paramount and shall be exercised through the agency of the State Corporation Commission.

Although this language refers to the control over the development of the waters of the state, it is obvious from the other provisions of the act, that powers of control vested in the Commission are restricted to development involving dam construction.

The primary feature of this control is the requirement that certain dams cannot be constructed without a license from the Commission. Included are: 1) all dams for the generation of hydroelectric energy for use or sale in public service and 2) dams across or in the waters of the state.

The agency's governing body consists of three Commissioners elected by joint vote of the two houses of the General Assembly for staggered terms of 6 years. Two of the Commissioners constitute a quorum for the exercise of the judicial, legislative, and discretionary functions; but a quorum is necessary for the exercise of its administrative functions. Provision is made for the election of a chairman. Existing practice involves annual rotation of the chairmanship among the Commissioners. Table A-27 summarizes the responsibilities of the aforementioned state agencies.

DISTRICT OF COLUMBIA

District of Columbia Water Law

The starting point with respect to water use of the Potomac River begins with the recognition that Congress has plenary power over the District of Columbia by virtue of Article 1, Section 8, Clause 17 of the Constitution. With the cession of territory by the State of Maryland to the United States, that now comprises the District of Columbia, the rights possessed by the state in that portion of the Potomac River lying within the ceded territory, and the soil under it, passed to the United States. In United States ex. rel Greathouse, v. Dern. supra, the court made the following statement with respect to that portion of the river within the District ceded to the United States:

> Within this area, Congress has the plenary powers to control navigation which had vested within the several states. It also acquired by the cession proprietary powers over the lands lying under water, and under article 1, Secs. C1.17 of the Constitution, granting exclusive legislative power over the District, the sovereign power to regulate and control their use for public purposes other than navigation (289 U.S. at 354).

In United States v. Groen, supra, the court concluded that:

> Title to the Potomac River and its tributaries, including the Eastern Branch, and the soil thereunder below the natural ordinary high water mark, is vested in the United States for the benefit of the people. This principle is so well established in law in the District of Columbia that, it is submitted, it may be considered of the dignity of a rule of property.

TABLE A-27

INSTITUTIONAL MANAGEMENT COMMONWEALTH OF VIRGINIA STATE AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
State Water Control Law (Va. Acts of Assembly '46)	State Water Control Board	X	X				X	X	X	As general responsibility for the State's water quality control program and exercises several specific functions in connection with the administration and enforcement of the State Water Control Law. Areas include the establishment of water quality standards: the issuance of certificates to parties causing pollution: establishment of requirements for waste treatment facilities administration of financial assistance programs: water quality planning: certification of projects requiring Federal licenses: and comprehensive river basin planning.
Va. Acts of Assembly, 1871-72, ch. 91	State Department of Health	X				X	X	X	X	Activities include control over public water supplies, regulation of sewage disposal, etc. Has general supervision and control over all water supplies and waterworks in the State insofar as the sanitary

TABLE A-27
(Cont'd)

INSTITUTIONAL MANAGEMENT COMMONWEALTH OF VIRGINIA STATE AGENCIES

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	State Department of Health (con't)									and physical quality of waters furnished for drinking purposes and domestic uses which may affect public health.
Constitution of Virginia	State Corporation Commission		X				X	X	X	Regulates rates and charges and services for water supply and sewer companies.

Congress has dealt with the water needs of the District by the establishment of the Washington Aqueduct and delegation to the Chief of Engineers of the planning and operational responsibilities relative to providing the District and certain nearby suburban communities with their supply of potable water. (Act of March 3, 1859; 11 Stat. 435).

The free flowing Potomac is outside of the District of Columbia. Therefore, reliance on the Potomac as a source of potable water must be focused on waters above the District, and the drawing of water from the portion of the Potomac owned by Maryland is governed by whatever arrangement may be made between the United States and the state. In summary, the legal position of the District of Columbia is encapsulated within the power of the U.S. Government with respect to water supply for the District.

District of Columbia Administrative Structures

The executive power of the District is vested in the Mayor who is the chief executive office of the District Government. The Mayor's office is the central planning agency for the District and is responsible for the coordination of planning activities of the municipal government and the preparation and implementation of the District's elements of the comprehensive plan for the National Capital which may include land use elements; urban renewal and re-development elements; a multi-year program of municipal public works for the District, and physical, social, economic, transportation and population elements. The Mayor's planning responsibility does not extend to Federal and international projects and developments in the District, as determined by the National Capital Planning Commission, or to the United States Capitol buildings and grounds.

Administratively, the Mayor administers the personnel functions of the District covering employees of all District departments, boards, commissions, offices and agencies and through the heads of these divisions, supervises and directs their activities. In addition, he may appoint a City Administrator to assist him in carrying out his functions.

Subject to the limitation in Section 603 of P.L. 93-198, regarding the role of the Federal executive and legislative branches, relation of indebtedness as well as other items, the Mayor has charge over the administration of the financial affairs of the District and to that end he can:

1) supervise and be responsible for all financial transactions;
2) maintain systems of accounting and internal control;
3) submit to the Council a financial statement;
4) supervise and be responsible for the assessment of all property to assessment and special assessments within the corporate limits of the District for taxation;
5) supervise and be responsible for the levying and collection of all taxes, special assessments, license fees, and other revenues, and receive all moneys receivable by the District from the Federal government or from any court, agency, or instrumentality of the District;

Subject to the limitations specified in Title VI of the Self Government Act (Reservation of Congressional Authority), the Legislative power granted to the District is vested in a Council. The Council has the authority to perform the following:

1) create, abolish, or organize any office, agency, department, or instrumentality of the government of the District and to define the powers, duties, and responsibilities of any such office, agency, department or instrumentality;

2) review and comment on the comprehensive plan by the National Capital Planning Commission;

3) authorize the issuance of general obligation bonds (to refund indebtedness of the District at any time outstanding and to provide for the payment of the cost of acquiring or undertaking its various capital projects);

4) may by act authorize the issuance of negotiable notes, in a total amount not to exceed 2 per centum of the total appropriations for the current fiscal year;

5) for any fiscal year, in anticipation of the collection or receipt of revenues of that fiscal year, the Council may by act authorize the borrowing of money by the execution of negotiable notes of the District, not to exceed in the aggregate at any time outstanding 20 per centum of the total anticipated revenue;

6) may by act issue revenue bonds, notes, or other obligations to borrow money to finance or assist in the financing of undertakings in the areas of housing, health facilities, transit and utility facilities, recreational facilities, college and university facilities, and industrial and commercial development.

Items 4 thru 6 however are dependent upon a fiscal analysis of the system of the District. Upon approval of the system, the Council will be able to issue the financial instruments mentioned.

Under the Mayor and the Council, a Department of Environmental Services exists to provide a safe, healthful, and aesthetically attractive environment in the District. The functions are:

1) plan, provide, operate and maintain sanitary services, systems and facilities which will maintain, improve, and promote the well-being of the community and its people, including distribution of water, control and disposal of storm water collection, treatment, and disposal of sewage; administration of revenue and special fund activities relating to water, sewer, and other services, cleaning of streets and alleys, and collections, processing and disposal of refuse;

2) prepare and recommend to the Commissioner, environmental criteria and standards, as well as rules, regulations and plans for their enforcement, for the following: air quality, water quality, radiation, noise, solid waste storage, collection and disposal and other areas of environmental quality problems in the District of Columbia;

3) conduct planning research and monitoring activities designed to detect, and provide an early warning of potential environmental quality problems in the District of Columbia;

4) at the request of the Mayor, or Deputy Mayor, conduct special investigations of, and make recommendations with respect to various actions having a potential impact on the environment of the District;

5) prepare an annual environmental plan describing the extent to whcih environmental quality goals and objectives of the District are being met and providing a forecast of environmental quality conditions, problems, and activities for the coming fiscal year as well as other duties.

The Department also has delegations of special authority:

1) Free Water Allowances - to fix and grant allowances of water, without charge to charitable institutions and churches;

2) Establishing Miscellaneous Fees - to establish fees for materials or services provided, in accordance with provisions of the Plumbing Code of the District;

3) Contract Authority - The Director of the Department is authorized to enter into and administer contracts and issue change orders under such contracts with respect to: a) consulting, architect-engineer and construction contracts on behalf of the District, including approval of performance bonds, when required; b) consulting, architect-engineer and construction contracts determined to be necessary for the proper performance of all types or classes of work now and hereafter placed under this supervision; and c) supplies, materials or equipment, the furnishing of services, or the performance of construction, in amounts not exceeding $50,000 when the public exigencies require the immediate delivery, furnishing, or performance of the same. In addition, the Department is the sole agency for the District for carrying out the Water Resources Planning Act of 1965. Table A-28 presents the institutional summary for the District.

SPECIAL ARRANGEMENTS - THE WASHINGTON AQUEDUCT DIVISION

The Washington Aqueduct is the water supply division for the District of Columbia as well as several other jurisdictions in the MWA. The Aqueduct which is part of the Corps of Engineers, collects the water from the Potomac River, provides treatment and conveys it to the District, Arlington County, and Falls Church. Responsibilities for distributing the treated water to consumers are assigned to the Department of Environmental Services of the District and to the Department of Public Works in Arlington County and Falls Church.

The money for operating the Washington Aqueduct comes from the private citizens and Federal agencies in the Nation's capital who are billed by the Department of Environmental Services for the water they use. Additional revenue is collected from the sale of water by the Aqueduct to Arlington County and the City of Falls Church in Virginia. All receipts are deposited in a special account by the District. Funds for operating, maintaining, and constructing new facilities for the Aqueduct are appropriated annually by Congress from this special account known as the District of Columbia Water and Sewer Enterprise Fund. Table A-29 summarizes functions of the Washington Aqueduct.

LOCAL WATER RESOURCES DEVELOPMENT

STATE OF MARYLAND

The Maryland portion of the Metropolitan Washington Area includes Montgomery, Prince Georges and Charles Counties. Within the suburban Maryland area, water supply services are provided by general governmental units, a state-created sanitary district, a county sanitary district, private companies, and Federal agencies.

TABLE A-28

INSTITUTIONAL SUMMARY DISTRICT OF COLUMBIA

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	City Council	X	X	X	X	X	X		X	
	Department of Environmental Services	X	X	X	X	X	X		X	

TABLE A-29

SPECIAL MANAGEMENT AGENCY

Applicable Act or Pending Legislation	Designated Institution	Planning, Policies	Financing, Policies	Acquisition, Policies	Construction, Policies	System Operation and Maintenance	Water Supply Mgt. and Admin.	Monitoring and Surveillance	Coordination Function	OTHER COMMENTS
	Washington Aqueduct Division through authority of Chief of Engineers	X	X	X	X	X	X	X	X	

General Governmental Units

Counties, cities and towns in Maryland derive their water supply management activities from several areas of the Maryland Code. Sections 78 to 91 of Article 23B of the Maryland Code outline the powers a city or town has in regard to water supply. A city or town may construct, operate and maintain a water system and water plant. The city or town may also extend its water systems beyond the town limits, contract with any party or parties for water services, and regulate private water systems. However, none of these powers extend to any city or town in a sanitary district or other special districts authorized to provide water services.

Article 43 of the Maryland Code contains other provisions relating to water supply and sewerage. To finance water and sewerage projects, a city or town may issue general obligation bonds. A referendum is required for bonds financing a water supply system, however.

Article 25 includes provisions allowing counties to establish public drainage associations and public watershed associations and to provide for erosion control. The powers and responsibilities of counties in regard to providing water supply are not specifically set forth anywhere in the Maryland Code. Under sections of Article 43, the counties may indirectly provide these services through creation of water authorities and sanitary districts. However, water authorities may not compete with existing public or private utilities. There are no water authorities, only the Charles County Sanitary District, in the Maryland portion of the Metropolitan Washington Area. The major water supply and sewage responsibilities of Maryland counties evolve from the state requirement that the governing body of each county must adopt countywide ten-year water and sewerage plans and annually review and amend them.

Only two cities and three towns in the Maryland portion of the Metropolitan Washington Area provide water services through public works departments. These are: the City of Bowie, the City of Rockville, the Town of Upper Marlboro, the Town of Indian Head and the Town of LaPlata.

Washington Suburban Sanitary Commission

The Washington Suburban Sanitary Commission (WSSC) is the largest water supply and sewerage organization in the Washington area and serves approximately one million people. The WSSC was created by the Maryland General Assembly in 1918 to serve those areas of Montgomery County and Prince Georges County contiguous to the District of Columbia.

The Acts creating the WSSC and defining its powers, responsibilities and organization are codified in the Public Local Laws of Montgomery County Chapter 71, and in the Public Local Laws of Prince Georges County, Section 83. At present, the governing body of the WSSC consists of Commissioners serving staggered four-year terms. Three commissioners are appointed by the Montgomery County Council, and three are named by the Prince Georges County Executive.

Besides providing water supply and sewerage services, the WSSC is empowered to provide refuse collection and disposal services, and it does operate a sanitary landfill. The Commission is also responsible for approving or disapproving the location and

construction of all utilities in public ways within the Washington Suburban Sanitary District, and for the adoption and enforcement of erosion control regulations for utility construction within the Patuxent Watershed portion of the district.

The WSSC may finance its activities by issuing bonds guaranteed by Montgomery and Prince Georges Counties. The bonds may be paid off by a property tax levied by the counties and service charges which may vary on the area or sub-district basis. The Maryland Code makes WSSC rules and regulations superior to municipal ordinances and will not allow a municipal corporation to amend its charter in a way which would impair the Commission's sanitation and water and sewer related powers. In addition, none of the water and sewerage powers granted to municipalities in Article 43 of the Code are to affect the WSSC.

The major control over the WSSC is exerted by Montgomery and Prince Georges Counties through the appointment of Commission members and through the counties' power to approve, reject, or amend the county ten year water and sewer plans and the WSSC's six year capital improvement program. The Maryland-National Capital Park and Planning Commission (M-NCPPC) also has the right to review the county ten year water and sewer plans prepared by the WSSC. The M-NCPPC does not have veto power over the plans, but the county governing bodies must vote separately on each item recommended for change.

The Maryland Secretary of Health and Mental Hygiene also reviews and can approve or disapprove the ten year plans. Once a ten year plan is approved, no state or local authority can grant building permits or approve subdivision plans unless they are in accordance with the county plans.

The WSSC operates two large water filtration plants to supply its customers. One is the Patuxent River Filtration Plant near Laurel, and the other is the Potomac River Filtration Plant in western Montgomery County. Most of the sewage from Montgomery and Prince Georges Counties is treated at the District of Columbia water pollution control plant. The Act creating the WSSC in 1918 gave the Commission full power to contract with the District of Columbia or any other Federal authority for water and sewerage services. The WSSC took advantage of this provision and negotiated the Maryland-District of Columbia Sewage Agreement in 1924, and amended it in 1954.

Maryland-National Capital Park and Planning Commission

After the WSSC, the Maryland-National Capital Park and Planning Commission (M-NCPPC) is the largest regional organization directly influencing water supply and water quality management decisions in the Maryland portion of the Washington area. The Commission was established by the Maryland General Assembly in 1927 to provide public parks and planning services to those developing areas of Montgomery and Prince Georges Counties adjacent to the District of Columbia. Financial support for the Commission comes from ad valorem taxes which the governing bodies of Montgomery and Prince Georges Counties are directed to levy and collect. The Commission is also authorized to issue bonds guaranteed by the full faith and credit of the two counties.

The Commission or, at the county level, the county planning board, must approve subdivision plans before they can be recorded, can issue subdivision regulations, and can recommend zoning changes. The county governing bodies retain actual control over zoning regulations, with the Commission only having delaying powers. The laws relating

to the Maryland-Washington Regional District prohibit the issuing of a building permit unless adequate provision is made for disposing of waste, sewage, and drainage. Even though the Commission is given the power and authority to adopt all necessary rules and regulations to assure adequate sewage disposal from all buildings in the District, it has not made any significant use of this authority.

Private Water and Sewage Companies

Under Article 23 of the Maryland Code, corporations formed for supplying water have the power to acquire and possess land, water rights, and other property and, with the permission of local authorities, may lay pipe and construct works. The corporations also have the right to eminent domain. There are several private water and/or sewerage systems in Montgomery, Prince Georges, and Charles County but most of them are small.

COMMONWEALTH OF VIRGINIA

The local level of the Virginia portion of the MWA includes Arlington, Fairfax, Loudoun, and Prince William Counties and the independent cities of Alexandria, Fairfax, Falls Church, Manassas and Manassas Park. Water supply and sewerage services are provided by the general governmental units, water and sewer authorities, sanitary districts, and private water companies.

General Governmental Units

Title 15.1 of the Virginia Code provides for the organization and powers of counties, cities, and towns. The governing body of every county, city, and town is authorized to acquire, establish, maintain, and operate water works and other public utilities or to contract for such services. Any two or more political subdivisions may enter into such contracts as they may deem proper for the acquisition, construction, maintenance, or operation of any public works projects.

The establishment or extension of water supply systems to serve three or more connections must be approved by the county in which the system is located. Counties also have the power to regulate the installation of septic tanks.

Cities and towns may regulate and inspect public and private water supply systems. They also have specific powers to provide and operate water supply systems, or to contract with others for the provision of such services. Counties, cities and towns may finance the establishment, extension, or improvement of water supply systems by issuing revenue bonds or general obligation bonds. However, Article VII, Section 10, of the new Virginia Constitution requires an election before a county may issue any general obligation bonds in the public market. Cities and towns may issue any bonds up to 18 percent of assessed real estate valuation without an election, and above that amount if the voters approve bonds for a revenue producing project.

In northern Virginia, two counties and several cities and towns provide water supply:

1) Arlington County - The county's Utilities Department provides Arlington with water and sewer services and operates its own system. Finished water is purchased from the Washington Aqueduct.

2) Fairfax County - The county provides sewerage service through its Department of Public Works. The county has six main sewage treatment plants. Water supply is through the Fairfax County Water Authority.

3) City of Fairfax - Water and sewage service is provided by the city's Department of Water and Sewer Services. The city operates a reservoir and filtration plant on Goose Creek in Loudoun County. From their facilities, it supplies water to its residents, the Town of Herndon, the Loudoun County Sanitation Authority, and areas of Fairfax County adjacent to the city.

4) City of Falls Church - The city Department of Public Utilities provides water to its residents and areas of Fairfax County adjacent to the city.

5) Town of Vienna - This town is in Fairfax County, and it obtains its water from Falls Church (which buys it from the Washington Aqueduct) and from wells.

6) Town of Herndon - This town, in western Fairfax County, purchases finished water for distribution and resale from the City of Fairfax Goose Creek system.

7) Towns in Loudoun County - The towns of Purcellville, Middleburg, Round Hill, Hillsboro, Hamilton, and Lovettsville in Loudoun County all have small water systems drawing from wells or reservoirs. The town of Leesburg water supply system relies on groundwater supplies as well as a recently constructed Potomac River raw water intake and filtration plant.

(8) Cities in Prince William County - The cities of Manassas and Manassas Park presently obtain their water supply from wells. However, Manassas has a reservoir on Broad Run which supplies a major part of the city.

Water and Sewer Authorities

The Virginia Water and Sewer Authorities Act authorizes the governing body or bodies of one or more political subdivisions to create by ordinance, or resolution, a water authority. Passage of the ordinance must be followed by a notice of hearing and a public hearing, in each participating political subdivision. A referendum is required in a participating political subdivision if the governing body calls for one or if ten percent of the qualified voters in the subdivision file a petition with the governing body at the hearing calling for a referendum. The participating political subdivisions must file articles of incorporation with the State Corporation Commission; and if the commission finds that the political subdivisions have conformed to the law, and the result of the referendum if any, is favorable, the Commission shall then issue a charter, and the authority comes into being.

Any political subdivision may join or withdraw from an existing authority, but no political subdivision may withdraw after the authority has incurred any obligation. The procedures for joinder or withdrawal are similar to those for the creation of an authority except that there is no requirement for a hearing and no provisions for a referendum.

Each authority is governed by a board of five members, of not less than one member from each participating political subdivision, selected in the manner provided for in the ordinances creating the authority. An authority may acquire, construct, extend, operate and maintain any water system. Authorities also have the power to enter into contracts with the Federal government, the Commonwealth of Virginia and any of its agencies or instrumentalities, or with any unit, private corporation, association, or individual for the furnishing of water services to them or the provision of such services by them. Contracts may also be made with political subdivisions, corporations and individuals of Virginia, or any adjoining state for the joint construction and operation of any project which is partly in Virginia and partly in the adjoining state. All counties, municipalities,

and other public bodies are authorized to make conveyances to and contracts with any authority. Each authority is subject to the jurisdiction of the Virginia State Water Control Board.

Authorities may finance their project by the issuing of revenue bonds. There is no requirement for a bond referendum, and such revenue bonds are not debts of the Commonwealth or of any participating political subdivision. The Virginia portion of the MWA has three authorities created under the Virginia Water and Sewer Authorities Act.

Fairfax County Water Authority (FCWA)

The FCWA was created by the Fairfax County Board of Supervisors in 1957 for the purpose of acquiring, constructing, operating, and maintaining an integrated water system for supplying and distributing water in the county. In 1959, the authority's charter was amended to allow the authority to acquire, construct, operate, and maintain water systems, sewer systems, and sewage disposal systems in Fairfax County or partly within and partly without the county. The authority board consists of nine members appointed by the County Board of Supervisors for staggered three year terms.

Despite the amendment to its Charter, the authority does not operate any sewerage facilities. It is, however, the major supplier of water in northern Virginia. Most of the authority's water is presently taken from its Occoquan Creek Reservoir. However, permitted withdrawals of up to 50 mgd can be made from the authority's recently completed Potomac River raw water intake and filtration plant. Supplementary sources of water include wells and purchases from the City of Fairfax (Goose Creek System) and Falls Church (Washington Aqueduct).

Loudoun County Sanitation Authority

The Loudoun County Sanitation Authority was created in 1959 for the purpose of providing water and sewerage facilities to serve the needs of the entire county. At present, its activities are in the eastern portion of the county in the area known as the Lower Broad Run Service Area.

Sanitary Districts

Chapter 2, Title 21, of the Virginia Code provides for the creation of sanitary districts upon the petition of at least 50 qualified voters to the circuit court and a court hearing and determination that the property in the proposed district will be benefitted. A sanitary district cannot include the area of more than a single county. The districts are enlarged or abolished in the same manner as they are created.

Sanitary districts are supervised by the county governing body, and, in addition to water supply and sewerage services, they may provide garbage collection and disposal, parking lots, street lights, sidewalks, community buildings and recreational facilities, and fire-fighting systems. The district governing body may construct, operate, and maintain the facilities necessary for providing services or contract for the provision of the services. The district may also serve areas outside its boundaries under contract.

Besides imposing the normal service charges and connection fees, the district may levy a tax on property within the district, if necessary. The sanitary district can issue bonds, but a referendum must be ordered by the circuit court if a majority of the county governing body asks for one, or if at least 50 qualified voters petition the courts for one. There are seven sanitary districts in the Virginia portion of the MWA, and all seven are located in Prince William County. They are: 1) the Occoquan-Woodbridge-Dumfries-Triangle Sanitary District, 2) the Greater Manassas Sanitary District, 3) the Yorkshire Sanitary District 4) the Oak Ridge Sanitary District, 5) the Nokesville Sanitary District, 6) the Bull Run Sanitary District, and 7) the Dale City Sanitary District.

Private Water and Sewerage Companies

In the Virginia Code, the term "public utility" includes those companies providing water or sewerage facilities either directly or indirectly to the public. Companies furnishing water or sewerage facilities to more than 50 customers cannot provide service without a certificate of public convenience and necessity from the State Corporation Commission. The application for the certificate must include detailed plans of the facilities and a statement of qualification to engage in such activities.

The companies are charged with the duty of providing adequate service at reasonable rates. The State Corporation Commission may set rates if the companies' rates are found unreasonable, insufficient, or unjustly discriminatory. The State Corporation Commission may also order an increase in the level of water or sewerage service. There are two regionally significant private water and sewerage companies in northern Virginia. The Virginia-American Water Company, which provides water service in Prince William County, and the Dale City Service Corporation, which provides sewerage service in the Dale City Area of Prince William County.

WATER RESOURCES ACTIVITIES IN THE STUDY AREA

While the MWA Water Supply Study was concerned with an analysis of the region's water supply, it was by no means the only water supply related activity that was taking place in the MWA. There have been numerous Federal, State and local activities that have contributed to both understanding and solving the water resources problems of the region. This section of the appendix provides a brief overview of the water resources activities that are most relevant to water supply planning in the MWA.

CORPS OF ENGINEERS ACTIVITIES

BLOOMINGTON LAKE PROJECT

The Corps of Engineers' Bloomington Lake project is located on the North Branch Potomac River in Garrett County, Maryland, and Mineral County, West Virginia, about eight miles upstream of the confluence with the Savage River near Luke, Maryland. The project was authorized by the Flood Control Act of 23 October 1962 for the purposes of flood control, municipal and industrial water supply, water quality, and recreation. Construction began in 1971 and the project was operationally complete in 1981.

The project consists of a rolled earth and rockfill embankment about 296 feet high, a dike abut 90 feet high in an adjacent saddle, a gated spillway with five tainter gates in the left abutment, a controlled outlet works with a multi-level intake tower and concrete lined tunnel through the right dam abutment, and access roads. Recreation facilities will include a boat launch ramp, a picnic area, and a camping area. As presently authorized, the conservation pool has a storage of 92,000 acre-feet for low flow augmentation (water supply and water quality), a surface area of 952 acres, a shoreline of 13.6 miles, a maximum depth of 248 feet, and extends upstream 5.5 miles. The flood control pool provides an additional 36,200 acre-feet of storage for floods. The total surface area at the flood pool is 1,184 acres. The lake has a total depth of 282 feet and extends upstream 6.6 miles. During periods of low flow in the Potomac River, the project will release water from low flow augmentation storage for both water supply and water quality control.

Costs allocated to water supply in any Federal project are to be repaid by non-Federal interests in accordance with the provisions of the Water Supply Act of 1958, as amended. For the Bloomington Lake project, 33.2 percent of the project cost is allocated to water supply with 5.8 percent being allocated to initial water supply storage and 27.4 percent to future water supply storage. Contracts to purchase all the water supply storage were consummated in July 1982. For more details on the Bloomington project, the reader is referred to Appendix H - Bloomington Lake Reformulation Study.

BLOOMINGTON LAKE REFORMULATION STUDY

At the time of authorization, Bloomington Lake was one of three reservoirs under consideration in the North Branch as well as one of 16 reservoirs under consideration for the entire Potomac River Basin. Most of these reservoirs included potential water supply and water quality benefits for the MWA. Since then, no additional reservoirs have been authorized for construction, although water supply needs have continued to increase.

In April 1978, five Congressmen from the MWA (Harris and Fisher, Virginia; Spellman and Steers, Maryland; and Fauntroy, District of Columbia) formally requested a reformulation study of Bloomington Lake for the specific purpose of providing supplemental water supply to the MWA. The purpose of the reformulation study was two-fold: (1) to determine the full water supply capability of the presently authorized low flow augmentation storage in Bloomington Lake by identifying optimum reservoir release rules; and (2) to determine the feasibility of reallocating some flood control storage to water supply storage to furnish additional downstream water supply. The reformulation study was conducted as an integral part of the MWA Water Supply Study. For a detailed discussion of the conduct and results of the reformulation study, the reader is referred to Appendix H - Bloomington Lake Reformulation Study.

SAVAGE RIVER RESERVOIR PROJECT

The Savage River Reservoir was sponsored in 1935 by the Upper Potomac River Commission (UPRC) for the purposes of increasing low flow for industrial use, and to relieve stream pollution conditions along the North Branch Potomac River from Luke to Cumberland, Maryland. The project is located on the Savage River in Garrett County, Maryland, approximately 5 miles upstream from the junction of Crabtree Creek and Savage River, approximately 5 miles northwest of Bloomington, Maryland. The construction of an earth and rockfill dam, with a maximum height of 184 feet above the streambed, was started in 1939 under the Works Progress Administration. With

approximately 65 percent of the work completed, construction was suspended in December 1942 because of World War II. Construction was resumed in March 1949. The original design and final construction of the project was under the supervision of the U.S. Army Engineer District, Washington.

The project was first placed in operation in January 1952. The dam and reservoir were transferred to the UPRC for operation and maintenance under Federal regulations on 1 July 1953. The reservoir has a storage capacity of 20,000 acre-feet, which is primarily intended for regulation of stream flow for industrial purposes and pollution abatement with some incidental flood control protection provided by the storage capacity during scheduled periods of drawdown. The Savage River has good water quality, and releases from the Savage River Reservoir are used to dilute acidity in the North Branch Potomac River.

The primary purpose of the Savage River Reservoir was to maintain, during low flow periods in the North Branch Potomac River, a flow of 93 cfs (60 mgd) at Luke, Maryland. This 93 cfs (60 mgd) flow included natural flow in the North Branch Potomac River plus the Savage River Reservoir release. With the addition of the Bloomington Lake project as authorized in 1962, it is estimated that a flow of 305 cfs (197 mgd) could be maintained at Luke, Maryland.

At present, the UPRC operates and maintains the Savage River project in accordance with Federal regulations. The cost of operation and maintenance of these facilities is paid by Allegany County through the UPRC. Recently, the Potomac River water users (WSSC, FCWA, and Aqueduct) agreed to share with Allegany County the operation and maintenance costs of the Savage River Reservoir, as the Savage River water would be needed to dilute the acidity in the North Branch Potomac River. Further details on the project may be found in Appendix H - Bloomington Lake Reformulation Study.

EMERGENCY ESTUARY WATER PUMPING STATION

Public Law 91-665 of the 91st Congress, 2nd Session, known as the Supplemental Appropriations Act of 1971, authorized the Corps of Engineers to design and construct an emergency water intake located on the Potomac Estuary approximately 1,000 feet upstream of Chain Bridge. Funds were subsequently appropriated and construction began in December 1976. Construction was completed in the spring of 1979 at an estimated cost of $2.8 million.

The Emergency Estuary Water Pumping Station can withdraw a maximum of 100 mgd of water from the Potomac Estuary during emergency low flow conditions in the fresh water portion of the Potomac River. The Estuary water would be pumped to the Dalecarlia and McMillan Water Treatment Plants for mixing with fresh water and subsequent purification. The purpose of this project is to mitigate the severest impacts of a large water deficit, provided the quality of the Estuary water does not degrade during drought conditions to a point where continued withdrawal and treatment would endanger public health and safety. The Emergency Estuary Water Pumping Station is envisioned as a temporary measure until such time as other means are available to supplement the MWA's water supply sources.

It is important to note that the pumping station will operate only under emergency conditions when flow in the Potomac River is not sufficient to meet the WAD's water demands. Other constraints will also be imposed on the operation of this facility.

Mandatory restrictions implemented by the Metropolitan Washington Council of Governments would have to be in effect prior to operation and the water supply would have to be deemed acceptable for use by the Public Health Service.

POTOMAC EXPERIMENTAL WATER TREATMENT PLANT

Section 85b(2) of the Water Resources Development Act of 1974 directed the Corps of Engineers to study the feasibility of using the Potomac Estuary as a source of water supply. The authorization further directed the construction, operation, and evaluation of a pilot project for the treatment of estuary water. The purpose of the plant is to determine the feasibility of producing potable water from the Potomac River Estuary. The experimental plant is located on a two-acre site at the District of Columbia Blue Plains Water Pollution Control Plant. The plant was designed for a 1.0 mgd maximum flow rate with unit processes that, based on the present knowledge and technology, may produce treated water for many uses.

The overall objective of the project is to determine the technical and economic feasibility of using the Potomac River Estuary as a supplemental source of potable water in the MWA. Achieving these objectives requires the answer to a number of key questions:

1. Using the best available analytical techniques, what quality of water can be produced by commonly used water treatment processes?

2. Is the water produced by the demonstration plant of potable quality?

3. What are the optimum process combinations which will ensure production of potable water at a minimum cost?

4. What is the operational feasibility and reliability of a water treatment plant that would be operated only intermittently?

5. Finally, what are the estimated costs of such a water treatment plant with hydraulic capacities of 100 and 200 mgd?

The project has been designed to provide answers to the above questions. Cost constraints limit project duration to three years, including approximately six months of plant start-up, two years of plant operation, and six months of plant deactivation and preparation of the final report. The final report will be submitted to a review committee designated by the National Academy of Sciences-National Academy of Engineering (NAS-NAE), which has the responsibility for evaluating the scientific and engineering validity of the study. Following this review, the study will be submitted to Congress, as background data for use in evaluating proposed strategies for meeting the water supply programs in the MWA. More details on the pilot plant and its potential for use may be found in Appendix F - Structural Alternatives.

VERONA LAKE PROJECT

The Verona Lake Project was authorized by Section 85(a) of the Water Resources Development Act of 1974 (PL 93-251). The project is located in Augusta County, Virginia, about nine miles northeast of Staunton, Virginia, on the Middle River Branch of the South Fork of the Shenandoah River.

At the time of authorization, the increase in dependable flow (110 MGD) from the project was estimated to meet the local water supply needs at Verona-Staunton, Virginia, beyond the year 2020 and, together with the Bloomington Lake (135 MGD) and Sixes Bridge Lake (85 MGD), was identified as part of a long-range solution to the water supply requirements of the MWA. The project was estimated to provide 350,000 visitor days annually for water-related recreation and would increase fishing activity by 87,500 fisherman days.

Phase I Advanced Engineering and Design studies were started in Fiscal Year 1975 and were 80 percent complete through Fiscal Year 1978. Due to increased local opposition from citizens in the area and local officials withdrawing support for the project, the State Water Control Board also withdrew its support for the project. Consequently, the Governor of Virginia notified the Corps that the Commonwealth officially opposed construction of the project. Phase I planning was terminated and a brief negative report was prepared which recommended that no further action be taken towards construction of the Verona Lake project.

SIXES BRIDGE LAKE PROJECT

The Sixes Bridge Lake project was also authorized by Section 85(a) of the Water Resources Development Act of 1974. The project would be located in Frederick and Carroll Counties, Maryland, and Adams County, Pennsylvania, on the Monocacy River just downstream from its confluence with Toms Creek. The damsite would be two miles west of Keysville, Maryland. The increase in dependable flow (85 MGD) from the project would meet the estimated local water supply needs at Frederick, Maryland, beyond the year 2020, and, together with the Bloomington Lake (135 MGD) and Verona Lake (110 MGD) projects, was identified as a long-range solution to the water supply requirements of the Metropolitan Washington Area. The project was estimated to provide 300,000 visitor days annually for water-related recreation and increase fishing activity by 104,400 fisherman days.

The completion of the MWA Water Supply Study and the subsequent review by the National Academy of Sciences-National Academy of Engineering of both the MWA Water Supply Study and the results of the Pilot Estuary Water Treatment Plant testing program were prerequisites to further authorization of any work on Sixes Bridge. No funds were appropriated for any work on the Sixes Bridges project; nor was the project actively supported by non-Federal interests. Subsequently, the project was deauthorized in December 1981.

CHESAPEAKE BAY STUDY AND HYDRAULIC MODEL

The authority for the Chesapeake Bay Study and the construction of the Hydraulic Model is contained in Section 312 of the Rivers and Harbor Act of 1965. The major objectives of the study are to:

a. Assess the existing physical, chemical, biological, economic, and environmental conditions of Chesapeake Bay and its water resources.

b. Project the future water resources needs of Chesapeake to the year 2020.

c. Formulate and recommend solutions to priority problems using the Chesapeake Bay Hydraulic Model.

With the aid of the nine acre hydraulic model at Matapeake, Maryland, various conditions in the Bay will be similated. The Chesapeake Bay Hydraulic Model provides a means of reproducing, at a manageable scale, some of the physical phenomena that could occur throughout this large and complex system as a result of various alternative management strategies. In the Potomac Estuary, for example, the hydraulic model was used to investigate the various hydrodynamic impacts associated with the use of the Potomac Estuary as a source of water supply. For a more detailed presentation relative to the conduct and findings of the Potomac Estuary tests on the Chesapeake Bay Model, the reader is referred to Appendix F - Structural Alternatives.

PERMIT ACTIVITIES

Under the law of the United States, Congress has also given the Corps of Engineers regulatory responsibility to protect navigation channels and harbors against encroachment (Sections 9 and 10 of the Rivers and Harbors Act of 1899), and more recently to restore and maintain water quality by regulating the discharge of dredged or fill material in coastal and inland waterways and wetlands. The basis for the Corps of Engineers' responsibility to regulate the disposal of dredged or fill material is Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). The purpose of this program, which is part of the Corps of Engineers overall regulatory authority, is to insure that the chemical/biological integrity of waters of the United States is protected from the irresponsible and unregulated discharges of dredged or fill material that could permanently destroy or alter the character of valuable water and related resources. This program provides for the consideration of all concerns -- environmental, social, and economic -- in the Corps' decision-making process to either issue or deny permits.

WASHINGTON AQUEDUCT

As part of the water supply facilities providing water to the District of Columbia, and to Arlington, Falls Church, and Fairfax Counties in Virginia, the Washington Aqueduct Division of the Baltimore District, Corps of Engineers, operates an extensive raw water collection system in Maryland. The original Washington Aqueduct, consisting of a dam and intake structures at Great Falls, Maryland, and a 10-mile gravity conduit from there to the District of Columbia, was begin in 1854, and placed in service in 1863. This aqueduct system, which has been declared a National Historic Landmark, includes the historic Cabin John Bridge (Union Arch), the largest stone arch of its type in the world. An additional conduit was built in 1926, and a new intake building at Great Falls in 1968. This gravity supply system has a capacity of 200 million gallons per day. The Little Falls Pumping Station, at Brookmont, Maryland, was completed in 1958. This structure includes a dam, intake building, pumps of 450 million gallon per day capacity, a prestressed concrete access bridge, and a discharge conduit.

Control of the water supply system is vested in the Chief of Engineers (See Acts of March 3, 1859, and March 2, 1867, November 22, 1973 and Sec. 1800 of Revised Statutes). The project includes: administration; operation and maintenance of the collection, purification, pumping, and transmission facilities; protection of the water supply system; engineering; and construction of major water system additions and improvements. Authority to supply water to Arlington County, the City of Falls Church,

and other jurisdictions in Virginia is contained in Public Law 119, 69th Congress, approved April 14, 1926; and Public Law 118, 80th Congress, June 26, 1947. More details on the Washington Aqueduct may be found in Appendix D - Supplies, Demands, and Deficits.

OTHER FEDERAL ACTIVITIES

Of all the recent comprehensive Federal water resource related activities that have an impact on the MWA the two most significant programs are the EPA Chesapeake Bay Program and the U.S. Geological Survey Potomac Estuary Study.

In fiscal year 1976, Congress directed the Environmental Protection Agency to conduct a five-year $25 million study of the environmental quality and management of Chesapeake Bay resources. Through this study - known as the Chesapeake Bay Program - the EPA was directed to coordinate research to assess the principal factors adversely impacting the Bay's water quality by coordinating pollution research to analyze, store, and distribute research data; and to determine which government agencies have resource management responsibilities and ways to optimize coordination among them.

Existing Bay research and management activities involve a broad spectrum of interests and jurisdiction from Federal, state, and local government agencies to research institutions, commercial interests, and the public. In recognition of this diversity of concerns, EPA has designed its program to facilitate a cooperative and coordinated approach towards assuring the Bay's protection.

To assure the continuance of the cooperative effort represented by the Chesapeake Bay Program, EPA has encouraged state (Maryland, Virginia, and Pennsylvania) participation in all aspects of the Program. This has enabled EPA to receive assistance and support from state agencies in the areas of program planning, technical support, data compilation and processing, scientific planning, and technical program development and implementation. The lead agency in Maryland was the Water Resources Administration of the Department of Natural Resources. Its counterpart in Virginia was the Virginia State Water Control Board, and in Pennsylvania, the Department of Environmental Resources in conjunction with the Susquehanna River Basin Commission. These agencies served as liaisons between the Chesapeake Bay Program and other state agencies. This interactive effort was accomplished through the participation of state personnel on program policy, management, and working level committees.

The Chesapeake Bay Program was designed to complement environmental studies being done by other agencies, institutions, and citizens groups. Its objectives were to describe historical trends and to help determine the state of the Bay by evaluating ongoing research and providing new research efforts to fill in the missing pieces. The Program also attempted to project future conditions and use this information to develop and identify control and management strategies for Bay resources and to develop implementation plans for these strategies.

In keeping with its objectives, the end products of the Chesapeake Bay Program are to provide comprehensive information in the form of final reports, in five major areas: The State of the Bay; Alternative Control Methodologies; Management Methods and Applications; Feasibility of Control and Management Method Implementation; and Monitoring Strategies. The Program is presently scheduled to be completed in 1983.

The U.S. Geological Survey (USGS) is making an interdisciplinary study of the Tidal Potomac River and Estuary. This study blends USGS research with river quality assessment in the study of an estuarine environment. The overall goal is to understand the major aspects of hydrodynamic, chemical, and biological processes and their interaction in a tidal river-estuarine system. The study started in 1977 with the first field data collection efforts and is scheduled to be completed in 1983.

STATE AND LOCAL ACTIVITIES

THE JOHNS HOPKINS UNIVERSITY HYDROLOGIC SIMULATION MODEL

In September 1977, a research team from the Department of Geography and Environmental Engineering at Johns Hopkins University (JHU) was awarded a matching funds grant from the Office of Water Research Technology and support from the Interstate Commission on the Potomac River Basin, the State of Maryland, and the Commonwealth of Virginia. The purpose of this research effort was to develop and analyze potential operating policies for the reservoirs which serve the MWA. Dr. Jared L. Cohen and Dr. Charles S. ReVelle were co-principal investigators for the project, and Dr. Richard N. Palmer developed most of the computer models.

The two-year research effort resulted in the development of a series of optimization and simulation programs designed to model the water supply system which serves the MWA. These programs examined the operation of the three major water supply agencies that serve the region - the Fairfax County Water Authority (FCWA), the Washington Suburban Sanitary Commission (WSSC), and the Washington Aqueduct Division (Aqueduct) of the Army Corps of Engineers. Five potential sources of water were included in the investigation: Bloomington Lake, Savage Reservoir, Occoquan Reservoir, the two reservoirs located on the Patuxent River (Triadelphia and Rocky Gorge Reservoirs), and the Potomac River near Little Falls, Maryland.

During the first year of study, linear programming models were developed that were designed to determine optimal management strategies for the reservoir system under a variety of operational objectives and constraints. Results from these studies indicated that significant gains could be obtained if the reservoirs were managed conjunctively. Because of the constraints and limitations imposed by the use of a linear program, however, several important features were not included in these linear programming models.

The most important feature absent from the linear programming formulations was the Potomac Low Flow Allocation Agreement (LFAA). This document is a legally binding agreement that specifies the allocation of water to be made to the regional water supply agencies from the Potomac River during periods of drought. Although representing a first step in the regional management of water supply, the LFAA does not represent a comprehensive regional management plan. The LFAA specifies how water is to be allocated among the various jurisdictions during a drought; however, it does not give guidance to jurisdictions on how they might lessen the adverse impacts of water shortages during droughts.

Realizing the need for a hydrologic simulation model which would reflect the LFAA provisions and, at the same time, allow the user to "test" different operating strategies, the research team at JHU devoted its research during the second year to developing such a model. The result was a computer program titled "PRISM" which was designed to

simulate potential reservoir operation and water management strategies during droughts. The program calculates the inflows, storages, and releases from Bloomington and Savage Reservoirs on a weekly basis and evaluates their impact on water availability to the MWA. The LFAA is incorporated into PRISM to determine potential allocations from the Potomac River to the Aqueduct, FCWA, and WSSC. Downstream reservoir operation (for Occoquan and the Patuxent reservoirs) is simulated as well. Potential deficits in water availability for each service area are then calculated. The output from PRISM displays the state of the MWA water supply system (deficits, remaining reservoir storages, environmental flow-by, etc.) on a simulated week-by-week basis. As its name implies, PRISM was also designed to be "interactive" whereby model users could interact directly with the model at the beginning of each weekly series of calculations. The findings of the two-year JHU research effort are documented in a three volume report titled Policy Analysis of Reservoir Operation in the Potomac River Basin. Volume III of the report is devoted entirely to PRISM.

In November 1979, the Baltimore District Corps of Engineers contracted with Dr. Richard Palmer, primary author of PRISM, to modify the PRISM program for the purposes of the Bloomington Lake Reformulation Study. Working together, Dr. Palmer and Corps personnel developed a modified version of PRISM, hereafter referred to as PRISM/COE to differentiate it from the original PRISM/JHU program. A detailed discussion of the PRISM/COE model may be found in Appendix H - Bloomington Lake Reformulation Study.

STATE OF MARYLAND FLOWBY STUDY

In 1978, the Potomac River Low Flow Allocation Agreement was developed to provide an interjurisdictional mechanism for allocating water among the various Potomac water suppliers during periods of critical low flow. (Copy provided in Annex D - IV.) Signatories to the "Agreement" include the United States of America acting by the Secretary of the Army through the Chief of Engineers, the State of Maryland acting by the Governor and the Secretary of the Department of Natural Resources, the Commonwealth of Virginia acting by the Governor and the Chairman of the State Water Control Board, the District of Columbia acting by its Mayor, and the Washington Suburban Sanitary Commission acting by its chairman and the Fairfax County Water Authority acting by its chairman. The portion of the Potomac covered by the "Agreement" extends from Little Falls dam to the farthest upstream limit of the pool of water behind the Chesapeake and Ohio Canal Company rubble dam at Seneca, Maryland.

The need for maintaining sufficient water in the Potomac to protect in-stream values during periods of critical natural low flow is established in Article 2.C of the "Agreement". Article 2.C reads in part as follows:

> In calculating the amount of water available for allocation, the Aqueduct will determine, in consultation with the parties, and based upon then current conditions and information, any amount needed for flow in the Potomac River downstream from the Little Falls dam for the purpose of maintaining environmental conditions (environmental) flow-by) and shall balance such need against essential human, industrial and domestic requirements for water. The Aqueduct's determination shall be based upon the data and shall give substantial weight to conclusions for environmental flow-by submitted by the State (of Maryland).

In July of 1978, the U.S. Army Corps of Engineers developed a "Memorandum of Intent" for clarification of the environmental flowby/allocation formula portion of the "Agreement". The "Memorandum of Intent" stated that:

> ...the Washington Aqueduct will include along with the amount of water withdrawn from the subject portion of the river that amount designated as the environmental flowby. Thus, when the Washington Aqueduct determines that the amount withdrawn, combined with the environmental flowby amount, is equal to or greater than eighty (80) percent of the total daily flow, the Restriction Stage will be put into effect and allocation will begin.

Article 2.C established the primary "charge" and objective of the environmental flowby study conducted by the State of Maryland -- that is, the development of "conclusions" (environmental flowby recommendations and impacts associated with low flows) for the establishment of an "amount needed for flow in the Potomac River downstream from Little Falls dam for the purpose of maintaining environmental conditions." Beyond the primary study "charge" and objective, data collection and analysis was expanded in an effort to make a thorough examination of low flow effects on a broad range of environmental values and recreational activities from Seneca Pool to Little Falls, including a portion of the extreme upper estuary. Expansion of the study scope provided an information base that will enable the development of future management alternatives for the Potomac beyond the immediate and necessary need for the establishment of a flowby below Little Falls dam.

During the early phase of study design it was determined that only the lower fluvial portion of the Potomac (between Little Falls and Seneca Pool) would be measurably affected by potential low flows and water withdrawals. Previous Federal and state modeling efforts, as well as, some modeling done in conjunction with the flowby study, indicate that the tidal Potomac Estuary is not adversely affected by cyclic low flow conditions. Thus, the data collection and analysis focused on the fluvial Potomac.

Primary data collection for the study was conducted in the summers of 1978 and 1980 during periods of low flow. The final report to include the recommended flowby was completed in December 1981. For a complete discussion of the report recommendations and subsequent impacts on the results of the MWA Water Supply Study the reader is referred to Appendix D - Supplies, Demands, and Deficits.

COOPERATIVE WATER SUPPLY OPERATIONS ON THE POTOMAC

In November 1979, the Section for Cooperative Water Supply Operations on the Potomac (CO-OP) was established by the Interstate Commission on the Potomac River Basin (ICPRB), under its article III charter authority. The CO-OP consists of the ICPRB Commissioners of the District of Columbia, Maryland, Virginia, and West Virginia and is supported by a technical advisory committee comprised of representatives from the Fairfax County Water Authority (FCWA), Washington Suburban Sanitary Commission (WSSC), and the Washington Aqueduct (WAD) of the Corps of Engineers. The general purposes of the CO-OP are to assis in resolving issues relative to water supply for the Metropolitan Washington Area, assist in negotiating contracts and agreements for water supply, and to develop regulation procedures for reservoirs that provide water resources benefits within the Commission's boundaries.

The CO-OP section has developed and is using a water supply simulation model to evaluate the effectiveness of various daily reservoir operating strategies for meeting the future water supply demands for the Potomac River users in the Metropolitan Washington Area. The users include the FCWA, WSSC, and the WAD. The model will be used as a basis for operational decisions within the overall system as agreed to in the Water Supply Coordination Agreement which was consummated in July 1982. Additional information on the Coordination Agreement may be found in Appendix B - Plan Formulation, Assessment, and Evaluation.

NORTHERN VIRGINIA WATER SUPPLY STUDY

Early in 1977, the Virginia General Assembly adopted a resolution that addressed the water situation in the Northern and Southeastern areas of the Commonwealth. The resolution (House Joint Resolution 236) identified the State Water Control Board (SWCB) as the agency responsible for examining the nature and degree of the water supply situation. Additionally, a State Water Study Commission was created to provide the SWCB with legislative guidance and to aid the SWCB in obtaining public views.

The Northern Virginia Water Supply Study examined five major alternatives relating to the Northern Virginia area. The alternatives studied included skimming reservoirs in Northern Virginia, a Shenandoah River Pumpover, a Potomac River Pumpover, use of supplementary storage reservoirs, and interactive use of the Potomac River and storage reservoirs. Public meetings were held in October 1977 in the Northern Virginia area with the intent of securing public input and incorporating it into recommendations that were to be made to the Governor and General Assembly in December 1977.

Several recommendations were forwarded to the legislature in December 1977. Some of these were as follows:

a. That more detailed analysis of the proposed Potomac River and Shenandoah River pumpover projects be performed to determine a solution.

b. That rate structures and plumbing and building codes be implemented which encourage conservation.

c. That interconnections of finished water between distribution systems be constructed.

d. That the Occoquan Reservoir should be raised so as to provide for additional storage.

e. That the communities within the Northern Virginia area should coordinate management of regional water supplies during shortage situations.

BI-COUNTY WATER SUPPLY STUDY TASK FORCE

Under the auspices of the Washington Surburban Sanitary Commission, the Bi-County Water Supply Study Task Force was directed to analyze the demand-supply situation within the WSSC service area - Montgomery and Prince Georges County, Maryland, - so as to satisfy local demands to the year 2005. The consulting firm of Ecological Analysts, Inc., analyzed existing and projected water demands and potential deficits as well as impacts of various water use restrictions. The firm of Henningson, Durham, and

Richardson, Inc., then analyzed several structural alternatives within the Bi-County area in terms of financial, social, cultural, and environmental impacts. Based on the work of these contractors, the Task Force recommended two alternatives for further examination: Soil Conservation Service Lake Site No. 3 on Little Seneca Creek in Montgomery County and a Potomac River to Patuxent River pipeline. The WSSC awarded a contract to the firm of Black and Veatch, Inc. for design and construction studies on the Little Seneca dam site.

TOWN OF LESSBURG, VIRGINIA

In 1974, the Town of Leesburg was granted a permit to construct a raw water intake facility in the Potomac River withdrawing up to 3 million gallons of water per day from the Potomac. The Town's plans for construction, however, were delayed due to greater than expected costs for the intake and treatment facilities. Later, the Town reactivated this project and proceeded to construction. The intake and treatment structure are located east of the east end of Harrison Island and east of and adjacent to the Virginia Electric Power Company transmission lines. Construction of the intake and treatment plant started in 1979 and was completed in 1982.

FAIRFAX COUNTY WATER SUPPLY COMMITTEE

In the spring of 1977, the Fairfax County Board of Supervisors established the Fairfax County Water Supply Committee to provide information to the supervisors for the purpose of decision-making. With this task as their goal, the Water Supply Committee examined the Fairfax County Water Authority (FCWA) Service Area supply and demand characteristics. The Committee's conclusions and recommendations were published in September 1977. Basically, their recommendations were as follows:

a. Conservation measures should be adopted and enforced throughout the Service Area; however, this alone is not sufficient.

b. A raw water interconnection to the Occoquan Reservoir should be considered as an alternative.

c. An analysis of ground water within Fairfax County should be undertaken for the purpose of developing a drought augmentation source.

d. The development of finished water interconnections should be considered by the FCWA.

e. Costs of any project that contributes to solving the regional problem associated with Potomac low flows should be shared by the beneficiaries.

FAIRFAX COUNTY WATER AUTHORITY

Subsequent to the release of the Fairfax County Water Supply Committee Report, several consultants were engaged by the FCWA to determine the feasibility of several of the recommendations. The firm of Harza Engineers was engaged to determine the feasibility of raising the Occoquan Dam an additional 5 feet. Somewhat related is the analysis, also by Harza Engineers, of the effects construction of a Cedar Run Reservoir would have on the existing Occoquan Reservoir. The reports on these two projects were completed and, as a result, the FCWA has increased the height of the Occoquan Dam by

2 feet. This action, however, does not prevent further increases in the future. The FCWA also completed and dedicated in June 1982 a new intake on the Potomac River with an accompanying water treatment plant.

PRINCE WILLIAM COUNTY, VIRGINIA

In 1966, the firm of Wiley and Wilson, Inc., in their Comprehensive Report on Future Water Supply for Prince William County, examined several alternatives to meet future water demands. One alternative examined was the construction of an impoundment on Cedar Run, a tributary to the Occoquan Creek. In April 1977, the County submitted a permit request to the Corps of Engineers to construct a Cedar Run impoundment. In October 1978, the permit request was returned because the criteria necessary for permit review had not been met by Prince William County.

Within Prince William County, the Occoquan-Woodbridge/Dumfries-Triangle Sanitary District initiated a Comprehensive Water Study in October 1978. The purpose of this study was to analyze the existing distribution network and evaluate its adequacy in meeting existing demands as well as its capability to handle future flows from either a northern or western supply source. The results of this study will determine a schedule of priorities for upgrading the system which will then be included in the preparation of a comprehensive plan.

WASHINGTON METROPOLITAN REGIONAL WATER SUPPLY TASK FORCE

As a result of the findings resulting from the early-action phase of the MWA Study, the local governments formed a regional task force to develop a cost effective regional management strategy as recommended in the Corps' early-action phase. Formed in January 1980, the Task Force and its efforts were coordinated by Mr. Robert S. McGarry, General Manager, Washington Suburban Sanitary Commission and included representatives from state and local governments. The Task Force had both a Technical Advisory Group and a Citizens Advisory Group that worked effectively in negotiating a number of institutional agreements that were required to implement programs to meet the future water supply demands of the MWA. A more detailed discussion of the activities of this important group may be found in Appendix C - Public Involvement.

THE WATER SUPPLY PROBLEM

INTRODUCTION

Previous sections of this appendix have provided an overview of the characteristics of the MWA in terms of both natural and human resources. The combination of the limitations of the natural system under certain hydrologic conditions and the water demands generated by a growing concentration of users in the MWA form the basis for a potential water supply problem.

There have been several noteworthy droughts in the MWA since the 1800's with the most severe occurring in the early 1930's and the mid-1960's. These droughts were caused by below average precipitation over several years resulting in low streamflows and groundwater levels each succeeding summer. Because the MWA is very dependent on the Potomac River (close to 70 percent of the MWA's supply comes from the Potomac) the coincidence of low streamflow and large demand can result in a water supply shortage. The possibility of a shortage increases yearly as water supply use continues to grow with

an expanded MWA population. The lowest observed flow in the Potomac River was 388 mgd on 12 September 1966. Daily withdrawals from the Potomac for water supply purposes first exceeded this historical low flow in 1971 and have, to date, exceeded this flow over 80 times. With the recent completion of the Bloomington Lake project the dependable flow in the Potomac River has been increased; however, the potential for future water supply shortages still remains.

Similar to the conduct of the overall study, the Corps analysis of future water supply deficits was conducted in two phases. The first analysis was conducted as part of the early-action phase between 1977 and 1979. This analysis concentrated on defining future water supply shortages in terms of a rate of required flow (in million gallons per day, mgd) to compensate for the difference between demand and a predefined flow condition such as the minimum seven-day average flow occurring once in one hundred years. While simplistic in its approach, this type of examination established a reasonable design condition for formulating early-action plans.

As a result of the analysis conducted in the early-action phase, several positive actions were taken by non-Federal interests to minimize potential water supply shortages. Thus, the "without condition" for the long-range phase of study was revised to reflect these recent actions for improving the water supply situation. Additionally, the approach to problem definition in the long-range phase was further modified to consider shortages in terms of a volume of required supply (in million gallons, mg) to compensate for the volumetric difference between demand and supply over a historical drought such as occurred in the early 1930's or mid-1960's. A significant shortcoming of the early-action analysis was that the examination did not explicitly address ways of managing the volume of water stored in the MWA's existing reservoirs (Bloomington, Savage, Occoquan, and Patuxent) to maximize releases during a prolonged drought. Such an examination of the existing system's full capability in volumetric terms (mg) rather than flow rates (mgd) was accomplished during the long-range phase, and was a distinguishing factor between the problem definitions for the early-action and long-range phases of study. Although considerably more complex, the volume analysis provided a more accurate description of the water supply situation and potential water supply requirements. The following paragraphs provide a summary discussion of both the methodology employed and the results of the demand-supply-deficit analyses that were conducted during both the early-action and long-range planning phases of the study. A more detailed discussion of the deficits analyses may be found in Appendix D - Supplies, Demands, and Deficits.

PROBLEM DEFINITION: EARLY-ACTION PHASE

Projected water supply shortages in the MWA's three major service areas are affected to a large degree by the variable flows in the Potomac River. To determine the magnitude of these shortages as they related to Potomac River flow, a range of low flow frequencies (or recurrence intervals) and durations was examined to define potential deficits for the early-action phase. A recurrence interval was defined as the average interval in years between the occurrence of a flow, in this case a low flow, of a specified magnitude and an equal or more severe low flow. For the early-action phase, U.S. Geological Survey frequency curves were used to account for low flow frequency. Flow duration referred to the average length of time a given low flow would persist. Each flow duration was also associated with a particular recurrence interval.

The Corps of Engineers also devoted a significant amount of effort to forecasting water use in future years for each water service area by considering population, employment,

and housing trends. Water use was disaggregated into six major user categories (single family residential, multi-family residential, commercial/industrial, government/institutional, Federal government, and unaccounted for), and then a unit water use rate was developed based on the growth forecasts. Average annual water demands were projected and aggregated for each benchmark year, and modified to reflect monthly patterns of water use. Within each month, the demands were further manipulated to estimate the maximum 7-day average and 1-day peak demand.

Based on work performed for the NEWS Study and confirmed in the early-action phase, water shortages (difference between demand and supply) in the MWA are usually at their greatest during the month of August. Shortages were therefore calculated for the month of August, using four recurrence intervals (once in 100 years, once in 50 years, once in 20 years and once in 10 years) and three durations (30-day, 7-day, and 1-day). Maximum 1, 7, and 30-day water treatment plant capacities were obtained for the Patuxent and Occoquan facilities; Bloomington Lake was assumed to furnish a 135 mgd release throughout August; and an environmental flowby of 100 mgd was assumed to enter the Potomac Estuary. Table A-30 lists the projected regional shortages by recurrence interval, duration, and benchmark year. As expected, greater shortages would likely occur earlier in the planning period for shorter duration and lower frequency events. For example, a once in one hundred year recurrence shortage could be expected to surface as early as 1982 for a 1-day duration and as late as 2005 for a 30-day duration (see Figure A-30). Similarly, shortages could begin as early as 1986 and reach 279 mgd by the year 2030 for the 7-day, once in one hundred year probability whereas for the once in ten year frequency event of the same duration, shortages would not be expected until around 2022 and only reach about 38 mgd by the year 2030 (see Figure A-31).

In comparing the projected surpluses and shortages, the water utilities reached a general consensus that the once-in-100 year, 7-day low flow condition should be used for planning purposes in the early-action phase. This decision was reached for two primary reasons: (1) the estimated once-in-100 year, 7 day low flow in the Potomac River (401 mgd) roughly approximates the worst 7-day average low flow on record (404 mgd in September 1966); and (2) designing for peak one-day shortages is generally not cost-effective as the water utilities can use short-term drought management techniques to reduce water demands. The water utilities also selected a certain level of water conservation to be implemented during the planning period. Table A-31 provides a breakdown of water surpluses and shortages by major service areas using the Potomac River for the once-in-100-year, 7-day August condition. These surpluses and deficits were calculated by applying the allocation formula in the Potomac Low Flow Allocation Agreement. Surpluses and deficits are shown for both the baseline demands and as modified by the selected level of conservation (Conservation Scenario 3). The numbers in Table A-31 were used as the "Without Condition" in formulating early-action plans.

PROBLEM DEFINITION: LONG-RANGE PLANNING PHASE

As presented in the preceeding section, the supply and demand analysis in the early-action phase of the study reflected the planning knowledge and expected future conditions as of August 1979. Since the publication of the August 1979 Progress Report, the MWA water utilities and local governments have pursued several activities to accomplish their water supply goals. One of these activities is the ongoing program for water conservation within the region. Both FCWA and WSSC have adopted water rate structures which encourage water conservation, particularly during the summer months. In addition, the water utilities have continued to support an active consumer-education program.

TABLE A-30

REGIONAL SHORTAGES FOR THE POTOMAC DEPENDENT USERS*

(In MGD for Various Years and Durations)

FREQUENCY OF EVENT	1980			1990			2000			2010			2020			2030		
	30	7	1	30	7	1	30	7	1	30	7	1	30	7	1	30	7	1
1/100	188	76	35	91	-30	-80	27	-100	-154	-27	-159	-218	-85	-223	-287	-135	-279	-346
1/50	247	129	85	150	23	-30	86	-47	-104	32	-106	-168	-26	-170	-237	-76	-226	-296
1/20	349	221	171	252	115	56	188	45	-18	134	-14	-82	76	-78	-151	26	-134	-210
1/10	457	317	259	360	211	144	296	141	70	242	82	6	184	18	-63	134	-38	-122

*Assumptions: August supplies and demands
Baseline demands for WSSC, WAD, FCWA, and Rockville
100 mgd flowby
135 mgd from Bloomington Lake
Occoquan operating at 30, 7, and 1-day capacities of 84, 95, and 112 mgd, respectively
Patuxent operating at 30, 7, and 1-day capacities of 49, 55, and 65 mgd, respectively

FIGURE A-30
DURATION SENSITIVITY - REGIONAL SURPLUSES
AND SHORTAGES FOR POTOMAC RIVER USERS*

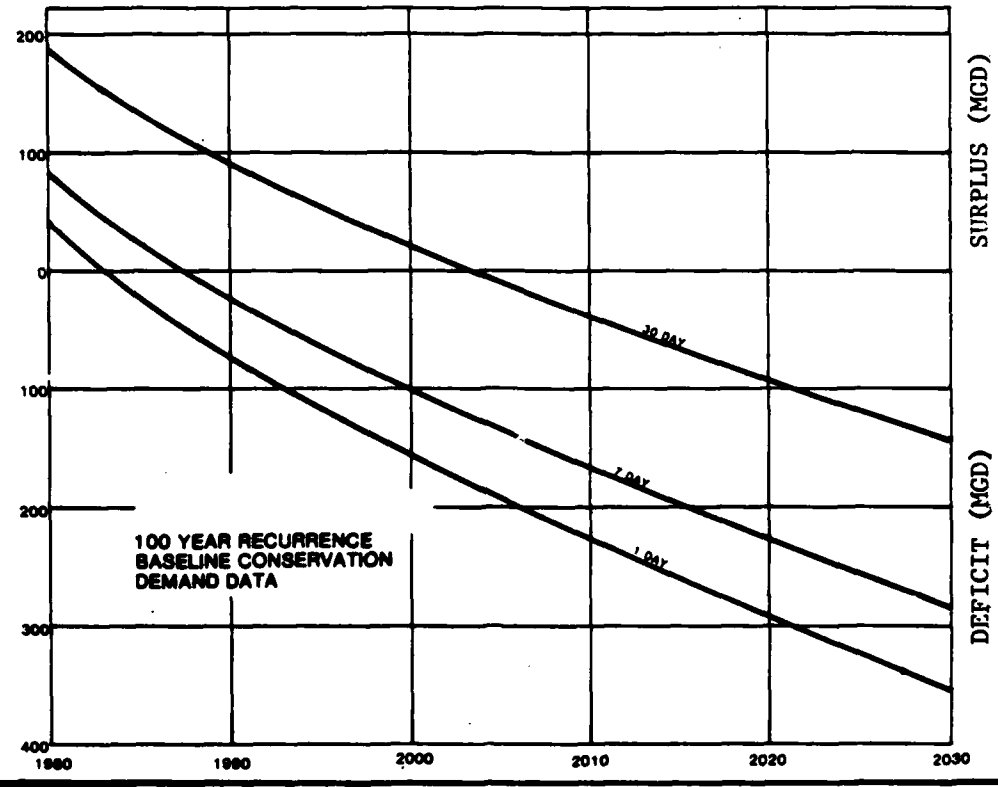
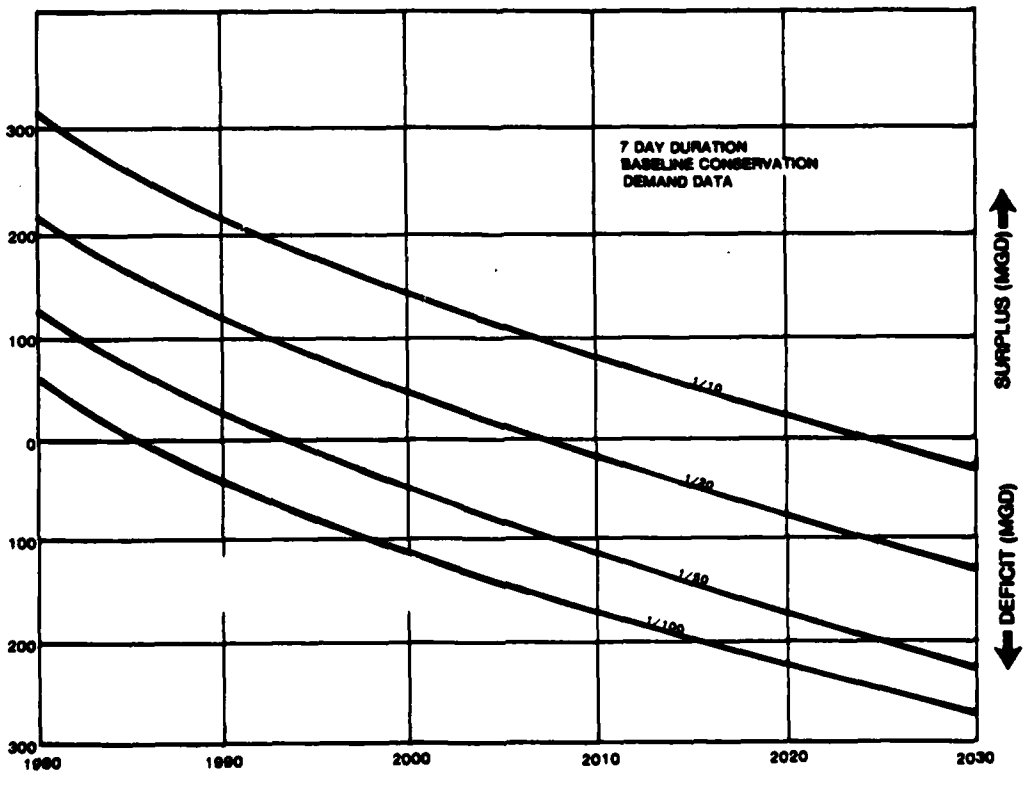


FIGURE A-31
FREQUENCY SENSITIVITY - REGIONAL SURPLUSES
AND SHORTAGES FOR POTOMAC RIVER USERS*



*See Table A-30 for a listing of the assumptions.

TABLE A-31

EARLY-ACTION PHASE
SERVICE AREA SURPLUSES AND SHORTAGES* (MGD)

WITH AND WITHOUT CONSERVATION SCENARIO 3

SERVICE AREA	YEAR					
	1980	1990	2000	2010	2020	2030
WSSC	+26(+37)	-17(+5)	-44(-13)	-69(-35)	-95(-56)	-119(-75)
FCWA	+5(+11)	-10(0)	-24(-12)	-38(-22)	-55(-35)	-70(-47)
WAD	+44(+55)	-3(+16)	-31(-3)	-51(-22)	-71(-41)	-88(-57)
ROCKVILLE	+1(+2)	0(+1)	-1(0)	-1(0)	-2(-1)	-2(-1)
REGIONAL TOTAL	+76(+105)	-30(+22)	-100(-28)	-159(-79)	-223(-133)	-279(-180)

*Surplus and shortages for individual service areas are based on application of the Potomac Low Flow Allocation Agreement, without the freeze provision. Calculations assumed 100 mgd flowby, 135 mgd from Bloomington, 1 in 100-year 7-day low flow in streams during August, Occoquan WTP operating at 95 mgd, and Patuxent WTP operating at 55 mgd. Numbers outside parenthesis indicate projected shortages (-) or surpluses (+) with Baseline demands; numbers inside parenthesis indicate projected shortages or surpluses with Conservation Scenario 3 demands.

The major accomplishment of the past three years has been the degree of regional cooperation which has been achieved. The importance of regional cooperation was first outlined in the August 1979 Progress Report. It was demonstrated that a regional water supply solution could provide significant cost-savings relative to independently pursued plans. The Progress Report also suggested that the solution to the MWA's problems could be implemented by the local users without assistance from the Federal government.

Given these findings, the local governments and water utilities realized that actions to solve future MWA water supply problems could be taken immediately. At the December 1979 meeting of the Federal-Interstate-State-Regional Advisory Committee (FISRAC), the members of that group initiated the formation of a regional task force to develop a regional water supply management strategy. This task force, the Washington Metropolitan Regional Water Supply Task Force, then set out to develop a plan of action for the region. As a result of its leadership, many of the benefits of regional cooperation have been attained. The plan of action which the Regional Task Force developed, and which is currently being implemented through the local jurisdictions and utilities, includes the construction of Little Seneca Lake, the purchase of the Bloomington Lake initial and future water supply storage, modifications to the Potomac Low Flow Allocation Agreement (LFAA), a regional water supply operation agreement, and a cost-sharing formula for any future water supply projects. The foundation of this plan of action is the utilities' intent to operate their systems and facilities from a regional supply and demand perspective. The regional water supply operation will be accomplished through the CO-OP (Cooperative Operations on the Potomac River) section of the Interstate Commission on the Potomac River Basin (ICPRB). The CO-OP section will be responsible for monitoring all of the water needs of the region, and then scheduling releases from Bloomington Lake water supply storage and Little Seneca Lake to supplement natural Potomac flow and withdrawals from the Patuxent and Occoquan Reservoirs.

The Regional Task Force plan of action is essentially fulfilled. The Little Seneca Lake project has received all of the necessary permits and approvals, a repayment mechanism has been negotiated, and construction was initiated in September 1982. A contract for the purchase of the water supply storage in Bloomington Lake has been consummated with the MWA utilities and local governments, as well as a contract to share the operation and maintenance costs of Savage River Reservoir with Allegany County. Additionally, the LFAA signatories have approved a modification which eliminates the freeze provision once Little Seneca Lake is completed and operational, and the CO-OP program is functioning.

In addition to the Regional Task Force activities, two related studies which affected the MWA supply and demand calculations were also undertaken in the three years since the early-action analysis. These studies were the Potomac River Environmental Flowby Study which was completed by the State of Maryland in 1981, and the Bloomington Lake Reformulation Study which is part of the overall MWA Water Supply Study and is included as part of this report (Appendix H).

The Potomac River Environmental Flowby Study was an outgrowth of LFAA negotiations in the mid-1970's. Under the terms of the allocation agreement, the State of Maryland was charged with assessing the effects of low flows on the Potomac River ecosystem and setting forth a recommended level of flow into the Potomac Estuary. The results of Maryland's investigations are published in their report, The Potomac River Environmental Flowby Study. Two of the recommendations resulting from the flowby study were: (1) a minimum daily flow of 100 mgd should be maintained below Little Falls intake, and (2) a

portion of WAD's withdrawals should be shifted from the Great Falls intake to the Little Falls intake when the flow at Great Falls approaches 500 mgd or less. These two recommendations, especially the recommendation for a minimum of 100 mgd of environmental flowby below Little Falls, were important elements in the redefinition of supply availability for the long-range study.

The Bloomington Lake Reformulation Study was initiated in January 1980. Its intent was to take a closer, more detailed look at the use of Bloomington Lake for water supply. The investigation had two purposes: (1) to examine the full water supply capability of the project and its most efficient use under existing Congressional authorization, and (2) to determine the feasibility of reallocating some water quality and/or flood control storage to water supply for downstream needs. The initial results of this study demonstrated that the water supply provided to the MWA from Bloomington Lake could be significantly increased by coordinated management of the area's reservoirs as a regional system. This preliminary finding, along with the jurisdictional movements toward a regional water supply approach, reinforced the need to reexamine the supply and demand assumptions used in the early-action planning effort to establish the base or "without" condition for the long-range phase.

In the early-action phase of the MWA Water Supply Study, the deficit analysis for the Potomac service areas used the Conservation Scenario 3 demands, based on MWCOG Round I population forecasts. For the long-range planning phase, these demands were reevaluated in the context of the current available information and found to be appropriate for use.

As in the earlier analysis, monthly demand variations were recognized; however, the weekly demand peaks of the early-action phase were not used in the long-range deficit analysis for several reasons. First, the simulation model which was used in the long-range deficit analysis showed that weekly demand peaks had little or no impact on the overall supply availability in a long-term drought. Second, emergency conservation measures, such as those required by the Metropolitan Washington Water Supply Emergency Agreement, would be capable of controlling large fluctuations in demand. Additionally, the Round II population forecasts indicated less future growth in the Potomac dependent service areas which was not reflected in the Round I monthly average demands. As a result, the Round I demands were considered conservative from a deficit point of view. The set of 2030 demands for WSSC, WAD, and FCWA service areas, which were used in the long-range phase formulation, are tabulated in Table A-32. These monthly demands are identical to those used in the early-action phase.

The early-action water supply base was significantly revised and modified for the long-range phase of the study, both to reflect changed conditions in the intervening three years and to overcome previous shortcomings. The early-action supply was based strictly on the 7-day and 30-day system capacities and statistical flow duration data. It did not address low flow periods of longer duration or the flexibility of a regional system which can trade-off between upstream and local impoundments. (A regionally managed system also has the advantage of allowing the water utilities to choose between reservoir and river withdrawals, to best meet their water demands.) The early-action analysis, which assumed a continuous release of 135 mgd from Bloomington Lake, did not consider variable Bloomington water supply releases to satisfy fluctuating regional needs. Consequently, the operation of the Bloomington project assumed in the early-action analysis was inefficient and not representative of regional cooperation which the region

TABLE A-32

LONG-RANGE MWA WATER SUPPLY DEMANDS
(YEAR 2030, CONSERVATION SCENARIO 3)

Demand (mgd)

Month	WSSC	WAD	FCWA	TOTAL
January	224	199	115	538
February	224	198	115	537
March	225	193	116	534
April	235	202	126	563
May	263	212	138	613
June	291	238	150	679
July	304	259	163	726
August	290	256	154	700
September	290	239	146	675
October	251	219	130	600
November	233	206	123	562
December	229	201	121	551

endorsed subsequent to the publication of the August 1979 Progress Report. The analysis also did not evaluate the effects of long-term droughts on the capability of reservoirs to deliver adequate quantities of water throughout the drought. In a long-term drought, the availability of storage would most likely be the limiting constraint of the supply system.

In addition to these two shortcomings, the early-action supply base did not include regional management of the Savage River Reservoir and did not account for travel time and flow losses between Bloomington Lake and the MWA's Potomac intakes.

Because of the need for improvement in some of the technical analyses, the early-action supply base methodology was critically reviewed for potential changes to be incorporated in the long-range planning phase. This review process culminated in the establishment of several analytical goals for the long-range planning supply base. These goals were:

(1) to examine Bloomington Lake and Savage River Reservoirs, in detail, as well as the other local reservoirs,

(2) to analyze the effects of several months of low flow as well as shorter periods, such as seven days,

(3) to incorporate the LFAA provisions and the reregulation plans for the Occoquan and Patuxent distribution facilities,

(4) to include the effects of transit losses and time between Bloomington and the MWA intakes,

(5) to evaluate the trade-offs between upstream and downstream (local) storage and between reservoir and river withdrawals,

(6) to examine the utility of regional cooperation by simulating the system's reservoirs for maximum, efficient use on a regional level,

(7) to investigate more effective release strategies for Bloomington, and

(8) to include flexibility in the supply parameters for additional analyses.

In order to meet these goals it was determined that a site-specific simulation model was the tool required to analyze the interaction of reservoir storage, streamflow and water demands. Additionally, the recent developments in the MWA water supply situation changed the character of the supply vs. demand problem. In the early-action analysis, the emphasis was on a rate of supply (Potomac flow and reservoir withdrawals) vs. demand. The realization of reregulation plans, Little Seneca Lake, Bloomington water supply storage, and regional cooperation, effectively reduced the short-term water supply flow problems. The remaining constraint in the supply situation was then the volume of storage available in a long-term drought. This volumetric supply and demand relationship became the major problem to be solved in the long-range planning phase. This type of problem lent itself easily to a simulation type of analysis.

The simulation model adopted for use was the Potomac River Interactive Simulation model originally developed by a research team at Johns Hopkins University. As modified by the Corps the model (PRISM/COE) is capable of simulating the operation and management of the MWA multi-reservoir and river system on a weekly basis for the 50 years of flow record between October 1929 and September 1979. The model incorporates

the major supply elements of the MWA system: Bloomington Lake, Savage River Reservoir, Triadelphia and Rocky Gorge Reservoirs, Occoquan Reservoir, and the Potomac River. (At the time of the PRISM/COE development in the late 1970's, the construction of Little Seneca Lake did not appear imminent; therefore, the reservoir was not included in the model. However, calculations were later made to account for Little Seneca Lake.)

As a result of its unique capabilities, the PRISM/COE model was used to simulate the without condition for the Potomac users in the long-range planning phase. The model also formed the basis for the supply analysis in the Bloomington Lake Reformulation Study since it was designed to evaluate the Bloomington storage in detail. The supply and demand baseline analysis for the outlying areas in the MWA was conducted separately from the Potomac users and is discussed in Appendix I - Outlying Service Areas.

The PRISM/COE model thus was the tool used to meet the goals established for improving the supply base in the long-range planning phase. A comparison of the analytical elements and/or assumptions used in both the early-action and long-range planning supply and demand analysis is included as Table A-33. This table demonstrates that, given the capabilities of the simulation model, the long-range planning phase was able to devote more analysis to reservoir storage and regional management.

With the redefined supply base and modified "without condition," a set of simulations was performed for 50 years of historical flow data between 1929 and 1979 using PRISM/COE. These simulations provided the base for the deficit analysis of the redefined "without condition" in the long-range planning phase. The data for this analysis are summarized in Table A-34. As noted in the data table, an estuary flowby level of 100 mgd was assumed in the without condition simulations. This value corresponds to the flow designated by the State of Maryland in its study as the minimum desired level of freshwater flow to the estuary. A summary of the simulation results for 1930-31 and 1966 flows are presented in Table A-35.

TABLE A-33

COMPARISON OF WATER SUPPLY BASE
AND DEMAND ASSUMPTIONS
EARLY-ACTION VS. LONG-RANGE

Description	Early-Action Planning	Long-Range Planning
MWA Demands	Round I forecast Conservation Scenario 3 Weekly peaks	Round I forecast Conservation Scenario 3 Monthly Average
Potomac Withdrawal Capacity		
FCWA	200 mgd	200 mgd
WSSC	400 mgd	400 mgd
WAD	650 mgd	650 mgd
Occoquan Max. Withdrawal	95 mgd	95 mgd
Patuxent Max. Withdrawal	55 mgd	55 mgd
Occoquan Storage	Not Addressed*	31,600 acre-feet
Patuxent Storage	Not Addressed*	31,000 acre-feet
Bloomington Storage, Total	Not Addressed*	92,000 acre-feet
Water Quality	Not Addressed	51,000 acre-feet
Water Supply	Not Addressed	41,000 acre-feet
Bloomington Release	135 mgd	Regional Need-Dependent
Travel Time of U/S Release	Not Addressed	47% 1st Week, 53% 2nd Week
Little Seneca Lake Storage	Not Addressed**	12,350 acre-feet
Little Seneca Lake Release	Not Addressed**	Offset Potential Deficits
Regional Management	Not Addressed	Systems Approach
Flow Data	Frequency-Duration	Recorded Drought Simulation

* The storages in these reservoirs were not analyzed in detail in the early-action analysis; however, their storage was considered as a supply source via their release capacity.

** Little Seneca Lake was considered in the plan formulation aspect, rather than the supply base.

TABLE A-34

SUPPLY AND DEMAND
WITHOUT CONDITION FOR LONG-RANGE PHASE

Assumption	Value
Bloomington Lake	
Total Conservation Storage	92,000 acre-feet (30,000 mg)
Water Supply Storage	41,000 acre-feet (13,370 mg)
Water Quality Storage	51,000 acre-feet (16,630 mg)
Minimum Release	32 mgd
Water Supply Release	variable
Seasonal Drawdown for Flood Control	yes
Savage River Reservoir	
Available Storage	18,000 acre-feet (5,900 mg)
Minimum Release	13 mgd
Seasonal Drawdown for Flood Control	yes
Flow Target at Luke, Maryland	78 mgd
Bloomington: Savage Release Ratios	time-dependent, flow-dependent
Water Supply Target Factor	0.6
Transit Factor, First Week	47%
Transit Factor, Second Week	53%
Flow Loss Between Luke and MWA Intakes	0 mgd
Occoquan Reservoir	
Water Supply Storage	31,600 acre-feet (10,300 mg)
Environmental Flowby	0 mgd
Minimum Withdrawal	30 mgd
Maximum Withdrawal	95 mgd
Patuxent Reservoirs (Triadelphia & Rocky Gorge)	
Water Supply Storage	31,000 acre-feet (10,000 mg)
Environmental Flowby	10 mgd
Minimum Withdrawal	20 mgd
Maximum Withdrawal	55 mgd
Little Seneca Lake	
Water Supply Storage	12,400 acre-feet (4,020 mg)
Environmental Flowby	1.12 mgd
Minimum Withdrawal	0 mgd
Maximum Withdrawal	275 mgd
Potomac Withdrawal Capacity	
WAD	650 mgd
WSSC	400 mgd
FCWA	200 gmd
Potomac Estuary Flowby	100 mgd
LFAA provisions	No Freeze
Demand Year	2030
Level of Conservation	Scenario 3

TABLE A-35

SUMMARY OF SIMULATION RESULTS FOR LONG-RANGE PHASE
WITHOUT CONDITION - 100 MGD FLOWBY

	1930-31	1966
Maximum Deficit, mgd		
WSSC	0	0
FCWA	0	0
WAD	0	0
Region	0	0
Cumulative Deficit, mg		
WSSC	0	0
FCWA	0	0
WAD	0	0
Total	0	0
Available Storage Remaining, mg		
Water Supply		
Bloomington	11,822	12,255
Occoquan	1,780	6,181
Patuxent	4,758	7,033
Little Seneca	3,797	3,082
Total	22,157	28,551
% of Capacity (37,790 mg)	58.6%	75.6%
Non-Water Supply		
Bloomington	13,275	13,645
Savage	4,801	4,731
Total	18,076	18,376
% of Capacity (22,530 mg)	80.2%	81.6%
Total Storage Remaining	40,233	46,927
% of Capacity (60,320 mg)	66.7%	77.8%
Weeks at Minimum Flowby Level	13	7

The "without condition" simulation for the long-range phase showed that the MWA supply system, as it currently exists, could satisfy 2030 demands (Conservation Scenario 3) without difficulty. For the longest historical drought (1930-31) as well as the severest low flow occurrence (1966), the system would experience no deficits. A key to the system's operation without deficits is the availability of Little Seneca Lake releases on short notice. On some occasions, unpredicted sudden drops in Potomac River flow may have caused deficits had not releases from Little Seneca Lake been immediately available.

For the 1930-31 drought, the simulated system operated for 13 weeks at the minimum flowby level. For the remaining simulated periods in the 50 years of flow record, the minimum flowby of 100 mgd was reached in a total of 11 weeks of system operation; 7 weeks during 1966, 2 weeks during 1964, and 2 weeks during 1932. Otherwise, the system passed higher flows into the Potomac Estuary.

Noting that the PRISM/COE simulations indicated the system could easily handle historical droughts with the 100 mgd flowby target, a sensitivity analysis using higher estuary flowby levels was performed. Additional flowby targets of 300 mgd and 500 mgd were selected for the sensitivity analysis. While the PRISM/COE simulation modelled the higher targets as an estuary need, the higher flowbys could also be viewed as additional system demands on the Potomac River source or as lower Potomac base flows. The additional Potomac demands could be the result of (1) larger population growth than anticipated in the Round I forecast, (2) higher unit water use than that indicated by Conservation Scenario 3, or (3) reduction in the water supply capability of an offstream source, such as the Occoquan or Patuxent Reservoir. In addition, the higher Potomac demand could conceptually represent a lower base river flow than that recorded in the past 50 years. Therefore, the higher flowby analysis was designed to evaluate how sensitive the MWA system was to greater demands or lower supply conditions than those in the "without condition" analysis which formed the basis for the long-range phase.

The simulation results for the flowby targets of 100, 300, and 500 mgd are tabulated in Tables A-36 through A-40 for the 5 major historical low flow periods. It should be noted that with the higher flowby requirements the total cumulative deficit can reach as high as 32,035 mg (1930-31 flows - 500 mgd flowby).

This section has outlined the supply and demand considerations which contribute to the definition of the potential water supply problem. As noted the problem definition process has undergone some significant changes over the course of the study. A more detailed discussion of the process and the results of the supply-demand analyses may be found in Appendix D - Supplies, Demands, and Deficits.

REGIONAL WATER MANAGEMENT CONCERNS

In defining and analyzing potential water supply shortages over the course of this study there have been a number of key issues or concerns that have had a significant bearing on both the nature and scope of the problem. Some of these issues relate to the impacts of the operation of physical structures while others center around more intangible variables. A further mention of the most important of these concerns is warranted in order to understand how solutions to the problems were formulated.

TABLE A-36

SUMMARY OF SIMULATION RESULTS FOR LONG-RANGE PHASE
WITHOUT CONDITION
1930-31 FLOWS

	Flowby Level, mgd		
	100	300	500
Maximum Deficit, mgd			
WSSC	0	38	173
FCWA	0	23	63
WAD	0	38	150
Region	0	99	362
Cumulative Deficit, mg			
WSSC	0	835	14,503
FCWA	0	607	4,928
WAD	0	942	12,604
Total	0	2,384	32,035
Available Storage Remaining, mg			
Water Supply			
Bloomington	11,822	0	0
Occoqan	1,780	0	0
Patuxent	4,758	2,707	1,379
Little Seneca	3,797	0	0
Total	22,157	2,707	1,379
% of Capacity (37,790 mg)	58.6%	7.2%	3.6%
Non-Water supply			
Bloomington	13,275	6,852	6,778
Savage	4,801	543	0
Total	18,076	7,395	6,778
% of Capacity (22,530 mg)	80.2%	32.8%	30.1%
Total Storage Remaining	40,233	10,102	8,157
% of Total Capacity (60,320 mg)	66.7%	16.7%	13.5%
Weeks at Minimum Flowby level	13	18	21

TABLE A-37

SUMMARY OF SIMULATION RESULTS FOR LONG-RANGE PHASE WITHOUT CONDITION 1932 FLOWS

	Flowby Level, mgd		
	100	300	500
Maximum Deficit, mgd			
WSSC	0	0	0
FCWA	0	0	0
WAD	0	0	0
Region	0	0	0
Cumulative Deficit, mg			
WSSC	0	0	0
FCWA	0	0	0
WAD	0	0	0
Total	0	0	0
Available Storage Remaining, mg			
Water Supply			
Bloomington	13,370	7,527	0
Occoquan	8,559	7,636	7,871
Patuxent	8,259	7,934	7,745
Little Seneca	3,931	2,673*	356*
Total	34,119	25,770	15,972
% ofCapacity (37,790 mg)	90.3%	68.2%	42.3%
Non-Water Supply			
Bloomington	16,040	13,855	13,890
Savage	5,619	3,881	1,748
Total	21,659	17,736	15,638
% of Capacity (22,530 mg)	96.1%	78.7%	69.4%
Total Storage Remaining	55,778	43,506	31,610
% of Total Capacity (60,320 mg)	92.5%	72.1%	52.4%
Weeks at Minimum Flowby Level	2	4	3

*This 1932 simulation started with the Little Seneca pool partially drawn down, due to 1930-31 releases.

TABLE A-38

SUMMARY OF SIMULATION RESULTS FOR LONG-RANGE PHASE
WITHOUT CONDITION
1963 FLOWS

	Flowby Level, mgd		
	100	300	500
Maximum Deficit, mgd			
WSSC	0	0	5
FCWA	0	0	6
WAD	0	0	10
Region	0	0	21
Cumulative Deficit, mg			
WSSC	0	0	34
FCWA	0	0	43
WAD	0	0	67
Total	0	0	144
Available Storage Remaining, mg			
Water Supply			
Bloomington	13,370	9,901	0
Occoquan	7,710	7,152	4,896
Patuxent	7,758	7,692	6,375
Little Seneca	4,018	3,998	0
Total	32,856	28,743	11,271
% of Capacity (37,790 mg)	86.9%	76.1%	29.8%
Non-Water Supply			
Bloomington	16,630	12,764	14,458
Savage	5,445	5,154	744
Total	22,075	17,918	15,202
% of Capacity (22,530 mg)	98.0%	79.5%	67.5%
Total Storage Remaining	54,931	46,661	26,473
% of Total Capacity (60,320 mg)	91.1%	77.4%	43.9%
Weeks at Minimum Flowby Level	0	3	7

TABLE A-39

SUMMARY OF SIMULATION RESULTS FOR LONG-RANGE PHASE WITHOUT CONDITION 1965 FLOWS

	Flowby Level, mgd		
	100	300	500
Maximum Deficit, mgd			
WSSC	0	0	0
FCWA	0	0	0
WAD	0	0	0
Region	0	0	0
Cumulative Deficit, mg			
WSSC	0	0	0
FCWA	0	0	0
WAD	0	0	0
Total	0	0	0
Available Storage Remaining, mg			
Water Supply			
Bloomington	13,370	8,341	0
Occoquan	8,676	7,662	5,040
Patuxent	7,169	6,986	5,840
Little Seneca	4,010	3,974	945
Total	33,225	27,073	11,699
% of Capacity (37,790 mg)	87.9%	71.6%	31.0%
Non-Water Supply			
Bloomington	13,820	13,034	10,305
Savage	5,069	4,218	1,003
Total	18,889	17,252	11,308
% of Capacity (22,530 mg)	83.8%	76.6%	50.2%
Total Storage Remaining	52,114	44,325	23,007
% of Total Capacity (60,320 mg)	86.4%	73.5%	38.1%
Weeks at Minimum Flowby Level	0	4	13

TABLE A-40

SUMMARY OF SIMULATION RESULTS FOR LONG-RANGE PHASE
WITHOUT CONDITION
1966 FLOWS

	Flowby Level, mgd		
	100	300	500
Maximum Deficit, mgd			
WSSC	0	0	235
FCWA	0	0	51
WAD	0	0	203
Region	0	0	487
Cumulative Deficit, mg			
WSSC	0	0	2,802
FCWA	0	0	713
WAD	0	0	2,343
Total	0	0	5,858
Available Storage Remaining, mg			
Water Supply			
Bloomington	12,225	862	0
Occoquan	6,181	6,163	5,764
Patuxent	7,033	7,171	6,789
Little Seneca	3,082	3,942	0*
Total	28,551	18,138	12,553
% of Capacity (37,790 mg)	75.6%	48.0%	33.2%
Non-Water Supply			
Bloomington	13,645	13,344	13,234
Savage	4,731	1,797	1,194
Total	18,376	15,141	14,428
% of Capacity (22,530 mg)	81.6%	67.2%	64.0%
Total Storage Remaining	46,927	33,279	26,981
% of Total Capacity (60,320)	77.8%	55.2%	44.7%
Weeks at Minimum Flowby Level	7	6	8

* This 1966 simulation started with the Little Seneca pool partially drawn down, due to 1965 releases.

WATER RIGHTS

As demands upon the Potomac River resources increase, age-old controversies of water rights in, on, under and adjacent to the River are being revived. Resolution of these conflicts is complicated by the multiplicity of jurisdictions concerned. The various states and the District of Columbia have diverse laws and sometimes conflicting interests. West Virginia and Pennsylvania presently make only minimal demands on the Potomac River, but are in an advantageous position with respect to the River's resources because of their upstream location and the associated riparian rights.

Based on the authority of a Compact in 1785 and subsequent rulings over the years, Maryland has been designated as owning the Potomac River to the low water mark on the Virginia side. Maryland ownership of the river was acknowledged as recently as 1958 in the Potomac River Compact. Because of these rights, Maryland has assumed an obligation to exercise management power along the Potomac" ...so that the waters can be preserved for future beneficial use." Accordingly, the Maryland Water Resources Administration has required both Maryland and non-Maryland entities to seek permission before making any appropriations of water from the Potomac River. On the other hand, Virginia claims the water drained from Virginia's portion of the Basin, which accounts for almost 50 percent of the total Potomac River flow; yet the Commonwealth must apply to Maryland for a permit to withdraw water.

Presently, an interstate conflict concerning water rights in the Potomac Basin centers on the issue of whether municipalities located outside of Maryland should be subject to the laws of Maryland when exercising riparian rights to Potomac waters.

The Maryland Water Resources Administration and the Virginia State Water Control Board have a Memorandum of Agreement concerning implementation of a water supply program for the MWA. As part of this pact, the two parties will review existing regulatory controls to assure an equitable allocation of available Potomac River water to both Maryland and Virginia users from the base flow as well as from water storage projects.

CORPS OF ENGINEERS REGULATORY ACTIVITIES

Under several authorities the Corps is charged with regulating certain activities in the Nation's waters. Over the course of the MWA Water Supply Study there were several significant permit applications which had a bearing on the development and management of the MWA's water supply resources. In July 1978, the Baltimore District, Corps of Engineers approved two applications for permits to construct water supply facilities on the Potomac River. One of these permits was granted to the Fairfax County Water Authority (FCWA) for construction of an intake facility at Lowe's Island in Loudoun County, Virginia. The Washington Suburban Sanitary Commission (WSSC) also received a permit to replace their existing intake structure on the Potomac with a new and expanded facility. The Corps also approved a permit for construction of a diversion weir across the north channel of the Potomac River near Watkins Island. The weir creates a constant pool which in times of low flow allows for maximum withdrawal at the expanded WSSC intake. All of the above proposals have since been constructed. Lastly, after a rather lengthly review and coordination process the Corps in April 1982 approved the application for the permit to construct the Little Seneca Lake Project in Montgomery County, Maryland. As noted elsewhere in this report, the Little Seneca Project is a significant element of the MWA's plan to meet future water supply demands.

LOW FLOW ALLOCATION AGREEMENT

The purpose of the Potomac Low Flow Allocation Agreement (LFAA) is to provide a fair and equitable means of sharing water resources available from all sources of supply during periods of low flow. The Low Flow Allocation Agreement was signed on 11 January 1978 by the United States Government, the State of Maryland, the Commonwealth of Virginia, the District of Columbia, the Washington Suburban Sanitary Commission, and the Fairfax County Water Authority.

The principal feature of the Agreement is a formula which would limit the amount of supplies available from all sources by each of the users during periods when flows in the Potomac are insufficient to meet the total demands. In such instances, each user would be allocated a percentage of the total available river flow based on a formula previously agreed to for dividing all supply sources. The Agreement will insure that the water resource is fairly distributed, but it will not eliminate shortages. Other important features of the Agreement provide for: (1) selection of a Moderator to enforce the Agreement; (2) a definition of river flows and reservoir storages subject to the Agreement; and (3) a mechanism to inform users of different shortages of river flow and their calculated fair share.

More recently, in July 1982, the signatories approved a modification to the agreement that eliminated the "freeze" provision in the agreement pending construction and operation of the Little Seneca Lake project. This clause would have allowed any signatory to "freeze" the allocation ratios after 1988 pending the negotiation of a revised formula. This modification was negotiated as part of the package of institutional agreements that were consummated by the MWA Water Suppliers in July 1982.

MAINTENANCE OF ENVIRONMENTAL FLOW

Directly involved with the permit actions and the Potomac Low Flow Allocation Agreement was the issue of maintaining an environmental instream flow. Known as flowby, this concept is defined as the amount of water allowed to flow past the last water intake on the Potomac (WAD), over Little Falls, and into the Potomac Estuary. Conceivably, full operation of all existing and future water supply intakes, coupled with a drought condition, could withdraw all water from the Potomac, leaving the river downstream of Little Falls with virtually no flow. The impact of such an occurrence on aquatic life in the affected portion of the Potomac as well as on water quality in the Upper Potomac Estuary could be severe.

Previously various values had been proposed for an appropriate level of environmental flow, ranging from 0 to 600 mgd with some values even higher. Water supply intakes upstream would be operated to maintain this predetermined downstream level of flow at all times. Obviously, higher levels of flow would require restrictions on water users much earlier in a drought situation.

As discussed earlier, article 2C of the LFAA called for the establishment of a flowby value based on a study to be conducted by the State of Maryland. The final report of the State was completed in December 1981 and included a recommendation for a flowby of 100 mgd. Subsequently, the signatories to the LFAA adopted the 100 mgd value as recommended in the Maryland report.

GROWTH

There is a desire on the part of many local groups in the MWA to control the development of the area and not accept continued growth as given or even necessary. The rapid expansion of the MWA has brougnt many problems, both social and fiscal, and managing growth is seen as the ultimate solution to the situation.

The debates have ranged from no-growth advocacy to more moderate positions of controlling the distribution of population. Local groups have expressed the fear that growth will be attracted by certain water supply projects. However, no group has ignored the potential which water and wastewater management offer for controlling growth. The measures recommended by these groups include restraints on regional water supply to curb the region's total population or control of water, sewer, fire, and other public services to coordinate growth and its distribution.

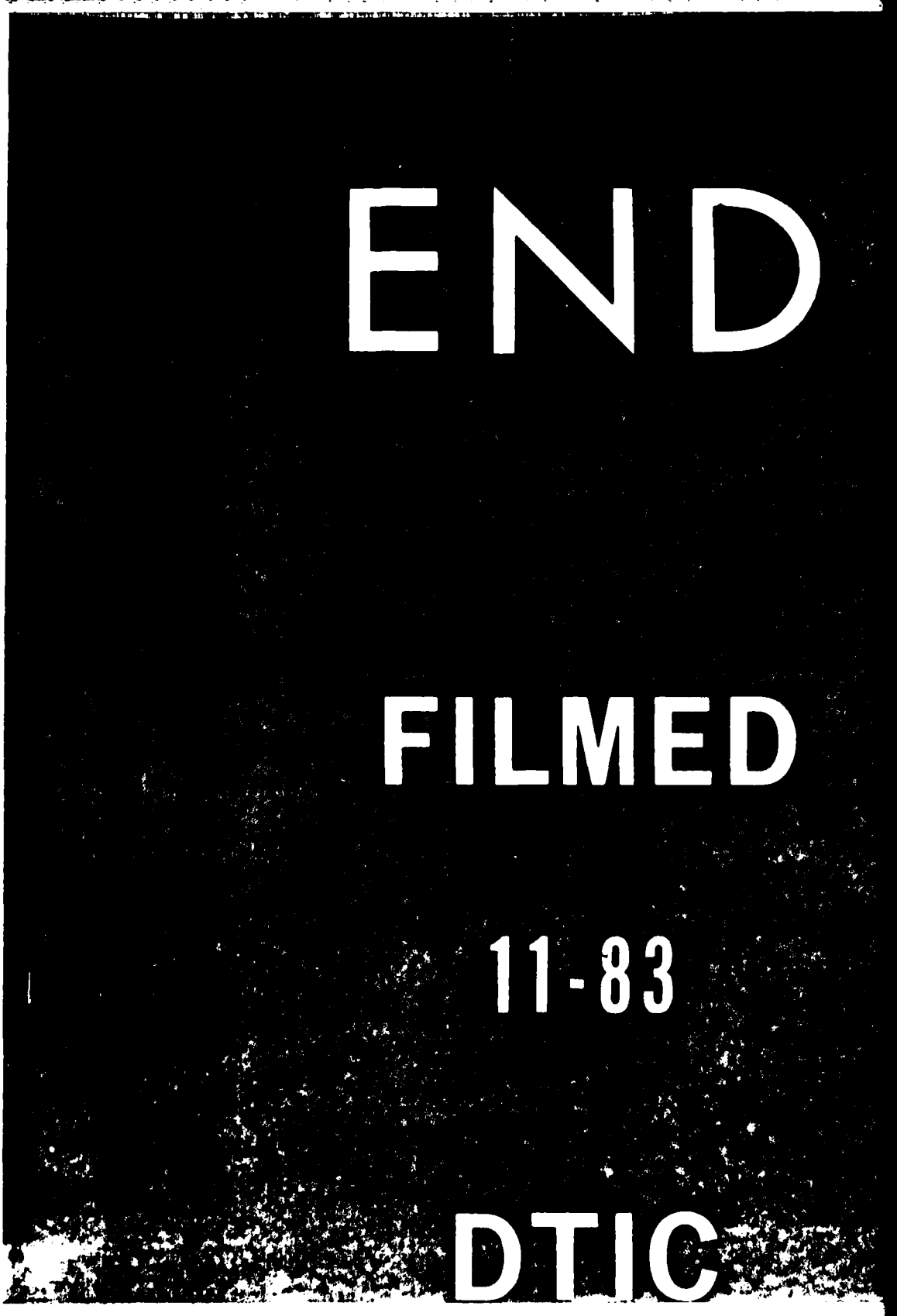
All water supply projects must be evaluated to determine their effects on growth and the ease with which land use controls could be implemented in the impacted areas of the projects. In this way it can be determined how consistent the effects of any given project will be with a given county's growth plans.

DEFERRAL OF DECISIONS

Early in the study an issue of great concern was the inability of all levels of government to reach collective agreement on the implementation of required regional water supply measures. Despite what was considered to be sufficient technical information, decisions on required future actions were being deferred for numerous reasons. Since the completion and findings of the early-action phase of this study great strides have been made toward the accomplishment of regional cooperation and the implementation of those measures required to meet future water supply needs.

WATER QUALITY

The discussion of the water supply problem thus far has been related to the quantity aspects rather than the quality aspects rather than the quality of the present and potential water supply sources. The quality aspects of the problem may be viewed from two perspectives. The first of these perspectives is the quality and/or treatability of the raw water to be treated for use in the MWA while the second is the attendant changes in the wastewater treatment systems that will be required with the expansion of water supply systems and their related development. The quality issue is viewed by many, to include the National Academy of Sciences - National Academy of Engineering Review Committee and the study's Citizen's Task Force, as being a critical element of the study. Although limited water quality investigations were made by EPA during the study, there have been strong arguments for a more comprehensive analysis that would consider in more detail the water quality/potability problems associated with meeting the MWA's water supply needs.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